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Soil Survey

La Porte County Indiana

By
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Purdue University Agricultural Experiment Station, in Charge
and
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United States Department of Agriculture
With a section on Management of the Soils of La Porte County
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Series 1934, No. 26 Issued September 1944

SOIL SURVEY OF LA PORTE COUNTY, INDIANA

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United States Department of Agriculture, in cooperation with the Purdue University Agricultural Experiment Station

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[1] The Soil Survey Division was transferred to the Bureau of Plant Industry, Soils, and Agricultural Engineering July 1, 1939.

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HOW TO USE THE SOIL SURVEY MAP AND REPORT

The soil survey map and report are intended to carry information concerning the soils, crops, and agriculture of La Porte County to a wide variety of readers.

Farmers, landowners, prospective purchasers, and tenants ordinarily are interested in some particular locality, farm, or field. Perhaps they wish to know what the soil is like on a certain piece of land, what crops are adapted, what yields may be expected, and what fertilization and other management practices are needed for best results. Often, they do not wish to read the whole report, and they need not do so to obtain much of the information essential to their purpose.

Anyone interested in a particular piece of land should first locate it on the colored soil map attached to the report. A legal description of the property will give the township, range, section, quarter section, etc., by which it can easily be found on the map. Then, from the colors and symbols, the soils may be identified in the legend on the margin of the map. Using the table of contents at the front of the report, the reader can find the description of the soil type or types. There is a description of the lay of the land, the natural drainage and other external characteristics, and of the internal or profile characteristics of the soil—its color, depth, texture, structure, and composition. Information is given about present land use, crops grown, and yields obtained; and, in some instances, suggestions are made concerning possible uses and present and recommended management.

The section on Productivity Ratings gives a general idea of how the various soil types compare with one another in productivity of the various crops and how well they are suited for the growth of crops or for other uses. Further ideas concerning land use and soil management can be obtained from the section on Management of the Soils of La Porte County.

For the person unfamiliar with the county or region, a general description of the county as a whole is included in the first part of the report. Geography, physiography, regional drainage, relief, vegetation, climate, population, transportation facilities, and markets are discussed. A brief summary at the end of the report gives a condensed description of the county and important facts concerning the soils and agriculture.

The agricultural economist and general student of agriculture will be interested in the sections on Agricultural History and Statistics, Productivity Ratings, and Management of the Soils of La Porte County.

Soil specialists, agronomists, experiment station and agricultural extension workers, and students of soils and crops will be interested in the more general discussions of soils in the section on Soils and Crops as well as in the soil type descriptions. They also will be

interested in the sections on Productivity Ratings and Management of the Soils of La Porte County.

For the soil scientist, the section on Morphology and Genesis of Soils presents a brief technical discussion of the soils and of the soil-forming processes that have produced them.

COUNTY SURVEYED

La Porte County is in the northwestern part of Indiana bordering Lake Michigan and the State of Michigan (fig. 1). The county seat, La Porte, is 65 miles from Chicago, 35 miles from Gary, and 25 miles from South Bend. The county has an area of 595 square miles, or 380,800 acres.

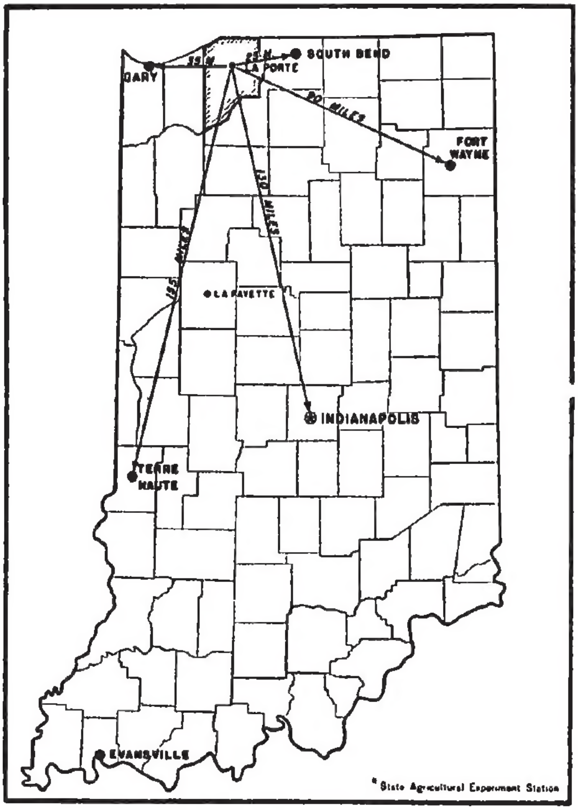

FIGURE 1.—Location of La Porte County in Indiana and air distances from the county seat to important places.

From abundant geological evidence it seems certain that all La Porte County, in common with a large part of the rest of Indiana and other northern States, was completely covered more than once by thick sheets of glacial ice, which moved slowly over the land and carried with them an enormous quantity of ground-up fragments of many kinds of rocks. The last ice sheet (called the Late Wisconsin glacier) is thought to have melted some tens of thousands of years ago and to have left its

load of crushed and crumbled rocks behind. Water from the melting ice deposited layers of gravel and sand where the current was swift, of silt where the current was slow, and of silt and clay in the quiet waters of lakes that filled depressions around the edge of the glacier. These deposits remain today as level or nearly level plains. Some of the more sandy deposits were whipped into dunes by strong winds around the border of the retreating sheets, and these dunes were later held in place by the forests that spread northward as the ice melted away. The material laid down by the ice without assortment into layers by water is known as glacial till; and large, irregular deposits of till are known as moraines. Geologists have given names of local places to some of the moraines, for example, Valparaiso moraine. Stratified deposits of material laid down by streams issuing from glaciers are called glacial outwash or simply outwash. Stratified silty and clayey materials laid down in lakes are called lacustrine deposits.

The land surface of La Porte County consists essentially of two belts of sandy and gravelly outwash plains separated by the Valparaiso glacial moraine (*6*).[2] These belts roughly parallel Lake Michigan. The land forms are the result of depositions made by the Late Wisconsin ice sheet and subsequent erosion in them. This sandy and gravelly material covers bedrock to an average depth of 200 feet under the moraine. It was deposited in part directly by the melting of the ice (as glacial till) and in part by glacial waters issuing from the ice sheet when it was melting (as outwash and lacustrine deposits).

Most of the stream valleys are shallow with gently sloping sides. The Kankakee River has a broad bottom, a widely meandering stream course, and gently sloping valley sides, which rise from 3 to 6 feet above the adjoining marshland. Geologists say it is the abandoned glacial stream course of what is now the St. Joseph River. Other streams in the county have a somewhat steeper gradient and meander in shallow-trenched valleys that show little relief.

The rolling moraine or till plain has been divided by geologists into two and possibly three morainic systems (*6*). The first, the Valparaiso morainic system consists of a dissected ridge which averages about 5 miles in width. The crest of this ridge rises to an elevation (*7*) of about 900 feet above sea level,[3] and its average elevation is about 830 feet. This is the most completely dissected section of the county. Streams head near lakes or muck beds in a narrow divide on the south side of the ridge and flow northwestward. The local relief ranges from 100 to 150 feet on the north side where the streams have cut down nearly to the level of Lake Michigan. The streams have narrow V-shaped valleys with small bottoms, and steeply sloping sides. Erosion is active, particularly on the heavier textured soils.

The second, or Lake Border morainic system, extending in a narrow strip through Waterford parallel to Lake Michigan, consists of several low rounded ridges of heavy-texture ground-moraine deposits. These deposits lie at an average elevation of 660 feet. Here, the relief is very moderate and erosion is unimportant. The few minor streams flow in depressions where soils are dark colored. Practically no fresh alluvium has been deposited in these places. The topography has been modified to some extent by sand dunes.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 109.

[3] U. S. Geological Survey. Three Oaks Quadrangle, Michigan-Indiana. Topographic map. 1930.

The sand plain bordering Lake Michigan consists of numerous sand-dune ridges and swells, alternating with low wet flats or marshes. The most striking of the ridges is the belt of high dunes rising 80 to 150 feet above the level of the lake and forming a continuous band around the lake, except for a break of about 400 feet at the mouth of Trail Creek. A continuous strip of coastal beach, from 50 to 100 feet wide, borders the lake in this county. The remnants of four former beach levels of Lake Michigan are in the vicinity of Michigan City. The general elevation of this section averages about 640 feet. This section was formed by the former glacial drainageway of the Galien River in Michigan and the Galena River flowing southwestward via Willow and Waterford Creeks into the Calumet River (*6*). An old channel 2 miles north of Otis, on the county line, marks the abandoned stream bed. A few small remnants of lake plains, such as those at Waterford and near Springfield Township School, give evidence of the ponding of water that occurred here when glacial waters flowed through this outlet. The present streams are entrenched in shallow valleys having average relief of 10 to 15 feet, except at the outlet of the Galena River, which adjoins the higher till plain (moraine). A bed of muck forms the divide between the Calumet River and Waterford Creek on the west side and between Trail Creek and the Galena River on the east side of this old glacial channel.

The largest physiographic unit consists of the outwash plain and the Kankakee marsh, together known as the Kankakee Basin (*2*). This basin section was smoothed and leveled when the glacial waters of the Paw Paw and St. Joseph Rivers flowed southwestward past the Valparaiso moraine. Subsequent recession of the ice allowed these streams to change their courses and flow northward through low divides and take their present course. The Kankakee Valley ranges in width from 2 miles at its beginning near South Bend in St. Joseph County to 5 miles at the point where it crosses the Indiana-Illinois State line and has a slope of about 1 foot to the mile. The present drainage ditch has a fall of 0.83 foot.[4]

The pitted outwash plain was formed from roughly assorted sand, gravel, and shale deposited by swiftly flowing water from the melting glacier, the coarser materials being deposited on the outwash apron bordering the south side of the moraine. The plain is cut by southeasterly flowing shallow streams, most of which rise from 1 to 3 miles south of the moraine. In general, the local relief is slight on the main part of the plain, probably averaging less than 10 feet. The highly pitted and stream-dissected plain east of the Little Kankakee River is an exception. Here differences in elevation of 50 to 75 feet are common and erosion is active on the steep slopes. Gullying also is severe, especially where the sandy subtrata are exposed. Coarser materials were deposited on this higher plain. The elevation of the outwash apron fronting the moraine ranges from 775 to 810 feet above sea level. Apparently level, this plain has a southeastward slope of about 9 feet per mile. The average elevation of the main plain is about 760 feet.

Most of the Kankakee Valley was a swamp until the river was dredged. At the point where it leaves the county, the river has an

[4] FRAZIER, W. H., and SHAPIRIE, S. R. REPORT ON KANKAKEE RIVER SURVEY TO DETERMINE AREAS FOR RESTORATION. Ind. Dept. Conserv. 1934. [Unpublished manuscript with map.]

elevation of 659 feet [5] and the average elevation of the Kankakee Basin is about 670 feet. The area is drained by an extensive system of dredged ditches, which have made about 90 percent of the old marsh tillable.

Artificial drainage has been necessary to put much of the best farm land of the county under cultivation. According to the 1940 census, there were 59 drainage enterprises totaling 182,119 acres, of which 178,140 acres were sufficiently drained for normal crops; 2,592 acres partly drained for partial crops; and 1,387 acres undrained and unfit for any crop.

Table 1 gives additional data concerning the drainage enterprises.

TABLE 1.—*Length of ditches, tiles, and drains; acreage covered; and costs of the drainage enterprises in La Porte County, Ind.*

Drainage enterprises with—	Length of ditches	Length of tile	Length of levees	Area covered	Average cost per acre
	Miles	*Miles*	*Miles*	*Acres*	
Ditches only	372.9			214,300	$4.79
Tiles only		6 8		3,060	43.97
Ditches and tiles	25 9	20.7		8,340	12.80
Ditches and levees	21.0		3.0	15,300	7.68
Total	419.8	27.5	3 0	241,000	5.75

The Kankakee River ditch is the principal stream draining the area. Practically all drainage water south of the moraine flows through an extensive system of ditches to this stream. Trail Creek, the Galena River, and Spring Creek carry the water of the northern part of the county into Lake Michigan. The Valparaiso moraine is the divide between water flowing to the Atlantic Ocean and that flowing to the Gulf of Mexico.

Abundant supplies of good water are available for drinking purposes in all parts of the county. On the old marsh, wells are drilled to a depth of about 20 feet; on the outwash plain, generally to a depth of 25 to 30 feet; and on the moraine, generally to a depth of 100 feet or more. Artesian wells are common on the north side of the moraine. Wells drilled in the underlying rock strata are reported to yield salty unpotable water. Most streams carry an abundant supply of clear water. Many of them head in beds of muck.

The average elevation of the county is 730 feet, which is 149 feet above the level of Lake Michigan. The highest land is on the divide north of Westville, La Porte, Rolling Prairie, and Hudson Lake. The highest elevation recorded, 957 feet, is on a knoll east of Lambs Chapel (*10*). The lowest elevation is 581 feet on the shore of Lake Michigan. The maximum difference in elevation between the highest and lowest points is 376 feet; and the maximum local difference is 150 feet (*6*).

Elevations of a few points on the Monon route of the Chicago, Indianapolis & Louisville Railway between Wilders and Michigan City are as follows:

	Feet
Railroad crossing at Otis [1]	747
Highest point on the divide, about 1 mile north of Westville [1]	810
Railroad crossing at Wanatah [1]	732
Railroad crossing at La Crosse [1]	678

[1] Data from the Chicago, Indianapolis & Louisville Railway.

[5] See footnote 4, p. 6.

When the original settlers arrived, a large part of the county was forested (*4*). The hill land and the light-colored soils of the outwash plains supported excellent stands of oak, ash, walnut, sugar maple, and soft maple. Numerous groves of bur oak dotted the prairie, particularly along the stream courses, kettle holes, and small lakes. The sandy ridges of the Kankakee marsh and of the outwash plains, then locally known as barrens, were covered by pure stands of black oak and white oak. The marshes were covered by marsh plants including sedges, rushes, sloughgrass, goldenrod, aster, and wild sunflower. Some of the beds of muck, such as those in the vicinity of Mill Creek, were covered by heavy stands of tamarack. White pines were common on the sandy soils bordering Lake Michigan. The dark rich well-drained Prairie soils were thickly covered with Indian grass, bluejoint turkeyfoot (big bluestem), prairie beardgrass (little bluestem), blue joint, and numerous patches of wild flowers.

Few virgin stands of timber remain, as the forests have been cut over. The principal stands of timber are on land that is too steep; too poorly drained; or too sandy, droughty, or unproductive to be farmed. Assessors' data show that the northern tier of townships, together with Lincoln and Cool Spring Townships, have the highest percentage of land in timber. Where natural reproduction has been allowed, the trees are similar to those of the original forest. Practically pure stands of black oak and white oak grow on the deep sandy soils. A few white pines grow in the vicinity of Michigan City, together with pin oak on the dark wet sandy soils. A soft maple-ash type of forest is associated with the gray poorly drained sandy soils, together with some swamp white oak, sugar maple, and basswood. On the well-drained hill land and the light-colored soils of the outwash plains, sugar maple and beech predominate and considerable numbers of other species, such as white ash, American elm, white oak, black oak, red oak, and walnut are mixed with them. Bur oak, the principal tree of the prairie borders, grows mainly on the moderately dark soils adjoining streams and pot holes.

The undergrowth in the woods varies from place to place. Reproduction is active in places where the woods have not been pastured. Farm woodland totaled 26,538 acres in 1934 or 8 percent of all farm land, and 16,853 acres of this woodland was pastured. A study of the carrying capacity of a woodland pasture on Tracy loam and Tracy fine sandy loam near Wanatah indicates that 6 acres per animal unit do not furnish sufficient pasture to maintain animals during the pasture season—May to November (*5*).

The character of the cover on the organic soils varies with the degree of drainage and the state of decomposition. On the peat bogs are scattered tamaracks, with buttonbush, willow, and silver maple growing around the better drained borders. Blueberry and chokeberry, together with sphagnum moss, hypnum moss, winterberry, and fern, form a dense ground cover. The water table is within a foot of the surface of the better drained organic soils. Carlisle muck originally was covered with tamarack, elm, ash, silver maple, and some swamp white oak. Practically all of the timber has been cleared, and the land is now used for pasture and crops. Here, the water table lies at a depth of 2½ to 4 feet. Houghton muck, which is intermediate in drainage, originally was covered with coarse grasses and sedges.

The family of Levi Benedict settled near the present town of Westville, in the present New Durham Township in March 1829 (*4, p. 775*). In July, Adam Keith, Lewis Shirley, and their families settled in what is now Scipio Township. When the county was organized on January 9, 1832, 100 white families were living there. Originally laid out with three townships, the county was subdivided until it took its present form of 21 townships. Cass, Dewey, and Hanna Townships, originally part of Stark County, were added to La Porte County by an act of the Legislature in 1842; Lincoln and Johnson Townships were added in 1850.

When the early settlers arrived this region was occupied by Indians, who had all moved west of the Mississippi River by 1838. Many of the pioneers came from Ohio, New York, Pennsylvania, and other eastern States. The population increased rapidly until about 1860, and then at a steady pace until in 1940 it was 63,660. In that year the census classed 42,656 inhabitants as urban, and 21,004 as rural, of whom 11,630 actually lived on farms. According to the 1940 census, the population consisted of 57,567 native-born whites, 4,942 foreign-born whites, 1,148 Negroes and 3 persons of other races. The latter groups live mainly in and around La Porte and Michigan City.

In 1940, La Porte, the country seat, had a population of 16,180, according to the Federal census; and Michigan City, the largest city, had a population of 26,476. The rural population is well distributed over the county, although in the vicinity of La Porte and Michigan City the farms are smaller and the density of population is greater than elsewhere. The density of the rural population was 34.5 persons a square mile in 1940. Maj. Isaac Elston recognized the value of the site of Michigan City as a location for a harbor. He laid out a plat of the town in October 1832, but it was not filed until 1833, the same year that the plat of La Porte was filed. The incorporated small towns of the county are La Crosse with a population of 574, Westville 523, Long Beach 455, and Trail Creek 326. Estimated populations of the unincorporated villages are as follows: Wanatah 750, Rolling Prairie 450, Hudson Lake 200, Waterford 100, Hanna 480, Otis 175, Kingsbury 250, Mill Creek 100, Stillwell 229, Union Mills 400, and Wellsboro 310. Springville and Door Village are small villages. Door Village is the site of the old blockhouse built in 1832 for protection against Indian depredations. The county took its name from an opening in the forest at this village, which was called La Porte, meaning "the door."

When the county was first settled, the streams abounded with fish, and game of all kinds was plentiful. Fur trading and lumbering were important sources of income for the early settlers who also traded some food and liquor to the Indians for furs. The agriculture of the county developed rapidly, corn, wheat, and oats being the important crops of the prairie. Westville, Byron, and Michigan City were important wheat markets prior to 1845.

Railways, highways, and airlines cross the county and converge in Chicago; consequently transportation facilities are exceptionally numerous. Serving the county are main or branch lines of the following steam railways: Pere Marquette Railway; New York Central system; Baltimore & Ohio Railroad; Grand Trunk Railway system; Pennsylvania Railroad; New York, Chicago & St. Louis Railroad; Chesapeake

& Ohio Railway; Erie Railroad; and the Monon route of the Chicago, Indianapolis & Louisville Railway. In addition there is the electric line of the Chicago, South Shore & South Bend Railroad. The Goodrich Transit Co. furnishes steamship service between Chicago and Michigan City.

The county is well supplied with hard-surfaced highways and has a good system of graveled county roads. The earth roads are rather easily kept in condition, owing to the sand content of the soil. Probably 50 percent of the roads are well-graded earth roads. Deposits of gravel suitable for road purposes are not abundant, and the small gravel pits are principally on the Valparaiso moraine and on the outwash plains. Schools, churches, and telephone and electric lines are numerous. Most of the townships have modern consolidated schools.

La Porte County has a great variety of manufacturing industries, most of which are centered in Michigan City and La Porte (*14*). These industries produce the following: Creamery products; clothing; building materials; metal products, especially die and machine tools, boiler castings, drop forgings, metal patterns, stoves, and sheet-metal products; wood products, including house and porch furniture; electrical products, such as motors and equipment, washing machines, and restaurant and meat-shop supplies; medicines and medical supplies; farm equipment, such as threshing machines and seeders; and general equipment, especially railroad cars, excavating machinery, gas and oil engines, road machinery, motortrucks, tractors, trailers, and pistons. A tomato cannery is at Westville and several sawmills are throughout the county. The railroads furnish much employment on the tracks and in the shops. A large proportion of the population is employed in these industries.

CLIMATE

The climate of La Porte County is characterized by moderately warm pleasant summers, and moderately cold winters, being tempered by the proximity of the county to Lake Michigan. Continental shifts in the wind and frequent storms crossing northern Indiana prevent most of the prolonged hot humid periods in summer that occur farther inland from the lake. The prevailing winds are from the northwest in winter and from the southwest in summer.

The average annual precipitation of 37.15 inches is uniformly distributed. During July and August when precipitation is least and temperature and evaporation are highest, crops usually suffer to some extent from drought. This is particularly true on the loose sandy soils. Oats and corn were complete failures on the loose sandy soils during the drought of 1934, but fair crops of corn were produced on those soils that have moderately heavy textured subsoils. Spring rains occasionally delay tillage operations on the heavier textured soils. Preparation of the seedbed for such crops as oats and corn frequently is delayed by rains during March and April. An annual average snowfall of 50.6 inches usually protects small grains and leguminous hay crops from heaving.

The frost-free period ranges from 150 to 170 days from the southern to the northern part of the county. It averages 157 days at La Porte,

extending from May 6 to October 10. Frost has occurred, however, as late as May 31 and as early as September 11. Corn, grapes, strawberries, tomatoes, and a few other crops are susceptible to injury by late spring frost. The principal damage by frost is done on the low-lying organic soils in the Kankakee River Valley. Grapes planted on hillsides are less susceptible to damage from frost. Corn is most likely to be damaged on low-lying organic soils; consequently early maturing varieties are planted the latter part of June.

The favorable effect of Lake Michigan on the climate, together with topography and soil, has encouraged the fruit industry on the hilly land in the northern part of the county. Prevailing northwesterly winds retard growth in spring and have made this region favorable for growing peaches. Elevation and air drainage are increasingly important factors to be considered when selecting orchard sites farther east from the lake. The section near the Indiana-Michigan State line north of Rolling Prairie is regarded the most favorable for orchards.

Table 2 gives the most important data regarding the temperature and precipitation at the United States Weather Bureau station at La Porte.

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at La Porte, La Porte County, Ind.*

[Elevation, 810 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1904)	Total for the wettest year (1938)	Average snowfall
	°F.	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	27.4	65	−22	2.70	1.40	2.84	13.6
January	24.0	67	−24	2.31	2.66	5.17	11.7
February	25.1	67	−22	2.07	3.24	3.96	10.6
Winter	25.5	67	−24	7.08	7.30	11.97	35.9
March	36.1	88	−8	3.16	4.70	4.73	7.3
April	47.5	94	7	3.06	1.37	5.55	1.6
May	58.6	96	23	4.00	2.25	6.80	.2
Spring	47.4	96	−3	10.22	8.32	17.08	9.1
June	68.4	103	30	3.72	1.25	7.17	0
July	73.2	108	41	3.13	.94	10.84	.0
August	71.2	106	36	3.27	3.04	4.71	.0
Summer	70.9	108	30	10.12	5.23	22.7[illegible]	0
September	64.4	103	26	3.49	3.10	6.10	[1]
October	52.4	92	8	3.87	1.22	.30	.9
November	39.8	76	−5	2.87	.83	1.97	4.7
Fall	52.2	103	−5	9.73	5.15	8.37	5.6
Year	49.0	108	−24	37.15	26.00	60.14	50.6

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

The early settlers cleared small tracts of land in order to devote a few acres to corn, wheat, potatoes, and other crops for home needs. The production of corn, wheat, and oats, and the raising of livestock

soon became important. Agriculture developed rapidly in the northwestern part of the county on the well-drained land. The Kankakee River marshlands was the last section of the county to be placed under cultivation, and settlement there advanced gradually with the dredging of the Kankakee River and the auxiliary system of ditches.

A diversified agriculture is practiced. General farming, together with the important dairying enterprise and some livestock raising, furnish the principal sources of income. In the northwestern part of the county, orchard fruits, small fruits, and vegetables were early proved to be successful crops. With the rapid increase in population in this section, there has been a great increase in dairying, poultry raising, and truck gardening, and a decline in numbers of beef cattle, sheep, and hogs raised (*11*).

The southern two-thirds of the county has been and probably will continue to be largely a grain-farming area, although dairying, especially for the sale of fluid milk, is slowly gaining a foothold.

Table 3, giving the value of certain agricultural products, indicates their relative importance as sources of farm income.

TABLE 3.—*Value of certain agricultural products, by classes, in La Porte County, Ind., in 1939*

Crops	Value	Livestock products	Value
Cereals	$2,042,289	Dairy products sold	$959,849
Other grains and seeds	219,101	Poultry and eggs produced	468,019
Hay and forage	605,302	Wool shorn	5,974
Vegetables (including all potatoes and sweetpotatoes)	166,365	Honey produced	1,110
Fruits and nuts	141,864		
All other field crops	16,928		
Farm garden vegetables (except potatoes and sweetpotatoes) for home use	60,736		
Forest products sold	9,163		
Hothouse and nursery products	37 865		

CROPS

Important changes in the acreages devoted to various crops have taken place during the last three decades. The acreage in grain has contracted. Less wheat is grown than in the post-war year of 1919, and less corn is grown than in 1909, the year of maximum acreage after the dredging of the Kankakee River marshlands. These crops showed a slight upward trend between 1929 and 1934. Like wheat, oats reached its maximum acreage in 1919 and has since declined.

Hay has shown an increase since 1909. Nevertheless, the acreage reported in 1939 is only slightly more than half of that reported at the turn of the century when large areas of wild hay were cut. Timothy and clover is being replaced by alfalfa and legumes, although the acreage of timothy and clover is still large. The decrease in the demand for timothy corresponds to the decrease in the number of horses kept in cities; whereas the production of legume hay is stimulated by the increasing demands of the dairying enterprise. Alfalfa and soybeans are popular hay crops because of their resistance to drought. Another factor in this trend in recent years is that the soil-conservation program of the Department of Agriculture has emphasized the value of close-growing crops.

Soybeans have become an important crop for harvested beans, as well as for hay. Other crops that have increased in importance recently are mint, grapes, and apples. The numbers of fruit trees, however, are less than half of those reported in 1900.

Table 4 gives the acreages of the principal crops in stated years.

TABLE 4.—*Acreages of principal crops in La Porte County, Ind., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	43,481	40,407	54,351	71,627	61,047	53,858	63,955
Wheat	42,211	40,191	44,794	30,580	57,893	32,416	20,020
Oats	11,668	22,162	18,077	26,769	37,106	32,570	19,565
Rye	627	1,994	3,084	3,103	15,634	3,533	4,302
Dry beans (mainly soybeans)	-------	-------	89	22	75	8,270	31,454
Potatoes	-------	2,127	1,800	4,476	2,188	1,842	1,552
All hay	29,092	52,660	60,090	27,373	29,087	31,759	34,254
Timothy and clover	-------	-------	([1])	24,655	25,008	18,956	11,683
Alfalfa	-------	-------	20	17	737	4,491	8,626
Legumes for hay	-------	-------	-------	-------	154	6,860	12,806
Other tame hay	-------	-------	31,314	1,245	991	620	922
Wild hay	-------	-------	28,756	11,456	2,107	832	317
	Vines	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*
Grapes [2]	-------	-------	11,370	12,105	11,066	214,947	205,684
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples [2]	-------	88,970	79,412	56,552	30,438	37,577	41,686

[1] Not reported separately.
[2] Grapevines and apple trees are for the years 1890 (apple trees only), 1900, 1930, and 1940, respectively.

In addition to the acreage of corn harvested for grain, that from 9,718 acres in 1929 and 5,710 acres in 1939 was cut for silage or fodder or was used for other purposes. Oats, cut from 187 acres in 1939, were fed unthreshed.

The acreage of soybeans grown alone in 1939—31,418 acres—was more than three times the acreage grown in 1929; and the production of beans was more than sixteen times larger—247,378 bushels compared with 15,088 bushels.

Owing to the character of the soils and the proximity of markets, the more important sources of income are fruits, vegetables, and special crops. The chief crops grown on muck are potatoes, mint, and onions. The 1940 census reported 338 acres of mint grown in 1939 producing 5,300 pounds of mint oil. In 1939, 1,552 acres were devoted to potatoes, yielding 121,224 bushels. Comparable data in 1929 were 1,842 acres and 122,172 bushels.

In 1939, sweet corn produced on 386 acres was valued at $6,981; cucumbers produced on 64 acres, at $2,850; tomatoes produced on 260 acres, at $13,629; dry onions produced on 54 acres, at $5,456; and cantaloups produced on 70 acres, at $4,062. String beans were grown on 68 acres, cabbage on 50 acres, asparagus on 23 acres, and watermelons on 27 acres. The total value of all vegetables harvested for sale in 1939 was $57,057, and the total acreage was 1,182 acres.

Clover seed was produced on 2,602 acres in 1929 and 1,260 acres in 1939. Grapes, an increasingly important crop on loose sandy soils of the hilly land, produced 1,347,660 pounds from 205,684 vines in 1939. Strawberries yielded 100,466 quarts from 106 acres in 1939.

LIVESTOCK AND LIVESTOCK PRODUCTS

Most of the milk produced is marketed as fluid milk. According to the Federal census, 6,524,606 gallons of milk was produced in 1929 and 4,741,831 gallons, valued at $1,043,203 was sold as fluid milk. In that year 11,159 cows were milked. In 1939, 11,783 cows were milked, yielding 6,969,796 gallons of milk, of which 4,858,864 gallons, valued at $874,596, was sold.

Poultry products are an important supplementary source of income. In 1929, 352,638 chickens were raised, of which 150,595, valued at $150,595, were sold. During the same year 1,149,155 dozen eggs were produced and valued at $344,747. In 1939, 330,075 chickens were raised, of which 158,675, valued at $111,072, were sold, and 1,097,902 dozen eggs were produced, and valued at $175,664.

Interest in purebred and high-quality livestock is widespread. Well-bred horses furnish the power on most farms. A large proportion of the dairy cattle is of the Holstein-Friesian breed, and there are some Guernseys and Jerseys. Shorthorn is the most common breed of beef cattle, and there are some Herefords and Aberdeen Angus. Duroc-Jersey, Hampshire, and Poland China are the more popular breeds of swine.

The number and value of livestock, as reported by the Federal census in 1920, 1930, and 1940, are shown in table 5.

TABLE 5.—*Number and value of livestock in La Porte County, Ind., in 1920, 1930, and 1940*

Livestock	1920		1930		1940	
	Number	Value	Number	Value	Number	Value
Horses	10,492	$893,099	7,395	$686,489	[1] 5,867	$442,730
Mules	434	47,222	436	37,451	[1] 276	22,208
Cattle	23,103	1,505,120	22,204	1,299,084	[1] 24,788	1,246,638
Sheep	6,544	90,770	9,837	75,216	[2] 3,856	24,023
Goats	96	950	124	472	[3] 217	781
Swine	23,325	325,457	24,492	273,845	[3] 21,654	195,762
Chickens	[4] 156,449	[4] 148,341	155,991	135,712	[3] 149,434	91,155
Bees (hives)	960	4,456	1,723	6,892	313	1,059

[1] Over 3 months old on April 1.
[2] Over 6 months old on April 1.
[3] Over 4 months old on April 1
[4] All poultry.

FERTILIZER AND LIME

The use of fertilizers has increased enormously in the last two decades. The total amount spent for fertilizers increased from $7,336 in 1910 to $97,017 in 1920 and to 127,987 in 1939. In 1939, 1,301 farms, or about one-half of all farms, reported using fertilizer, and the average amount spent per farm was $98.38. Most of the fertilizer used is bought ready-mixed. Table 6 shows the formulas, the quantities used, and the crops for which fertilizers are most commonly applied, as reported by the farmers.

The use of lime on acid soils is recognized by most farmers as being essential in order to increase crop yields. On most soils it is impossible to grow clover without liming. All acid sandy soils make satisfactory response to the use of lime. Numerous failures of clover and its

response to liming indicate the need for the use of adequate quantities of lime, as an amendment, in order that legumes may be grown. Specific recommendations for liming are given in the section on management, pp. 84–105.

TABLE 6.—*Quantities and formulas of fertilizers commonly applied for crops on various soils in La Porte County, Ind.*[1]

Crop	Quantity	Formula	Soil fertilized
	Pounds		
Corn	100	[2] 0-14- 6	Light-colored clay and sand soils.
	65-125	0-14-14 0-12-12 0-14- 6 0-12- 6	Dark-colored sandy soils.
	100-150	0- 8-24 0- 8-32 (3)	Muck.
Wheat	100-200	0-12-12	Dark sandy muck.
	300	2-10- 8	Light loose sands.
	100-200	2-12- 6	"Clay" land.
Mint	100-200	2-12- 6 0-10-10	New muck land.
		2- 8-16	Muck that has been under cultivation a long time.
Potatoes	325-500	0-12-12 0- 8-32	Dark-colored sandy soil.
		0- 8-24 (3)	Muck.
Truck	600	3- 9-18	Do.

[1] Not to be construed as recommendations for use, for which see the section on Management of the Soils of La Porte County, pp. 84-105.
[2] Percentages, respectively, of nitrogen, phosphoric acid, and potash.
[3] Muriate of potash.

Table 7, taken from the 1940 annual report of the county agricultural agent,[6] shows the quantity of lime that has been used annually in the last 17 years.

TABLE 7.—*Lime purchased for use on farms in La Porte County, Ind., 1924–40*

Year	Transported by— Truck	Transported by— Railroad	Total	Year	Transported by— Truck	Transported by— Railroad	Total
	Tons	*Tons*	*Tons*		*Tons*	*Tons*	*Tons*
1924	----------	2,054	2,054	1934	----------	1,323	1,323
1925	----------	6,600	6,600	1935	5,513	2,052	7,565
1926	----------	6,120	6,120	1936	12,364	880	13,244
1927	----------	8,800	8,800	1937	24,153	808	24,961
1928	----------	7,250	7,250	1938	12,797	626	13,423
1929	----------	5,950	5,950	1939	16,468	385	16,853
1930	----------	7,552	7,552	1940	52,536	250	52,786
1931	----------	2,900	2,900				
1932	----------	2,469	2,469	Grand total	123,831	58,809	182,640
1933	----------	2,790	2,790				

Marl, ground limestone, hydrated lime, and byproducts of lime are used—the first two more commonly and economically. La Porte County has abundant supplies of marl, which are beginning to be widely used. Marl is cheap and is equal in effectiveness to any of the more expensive forms of lime. The principal disadvantage of its wider use is its physical condition and the difficulty of spreading it.

[6] HARTMAN, EVERETT L. ANNUAL NARRATIVE REPORT OF COUNTY AGRICULTURAL AGENT, LA PORTE COUNTY, INDIANA, FOR THE YEAR ENDING NOVEMBER 30, 1940. [Typewritten report on file with the U. S. Dept. Agr. Ext. Serv.]

Marl deposits are widely scattered over the county, the largest ones being south of Fish Lake, north of Springville, southeast of Pinhook, and southeast of Hanna. The marl, a light-gray or bluish-gray silty form of lime, generally lies at a depth of 3 feet or less under beds of Edwards muck; but, in places, as at Fish Lake, it is on top of the ground.

FARM LABOR

Owing to competition of farming with manufacturing, farm labor in La Porte County tends to be scarce and expensive, especially during periods of industrial prosperity. About 40 percent of the farms employ additional labor. In 1939, the total expenditure for farm labor was reported as $274,161 by 1,000 farms, or $274.16 a farm reporting. This amount was about 87 percent of the amount reported for 1929. Scarcity of labor has been in part responsible for the greater diversity of crops in the grain-producing section and for the extensive use of power machinery. This, in turn, was a factor in the increase in size of farms from 1900 to 1930.

NUMBER, SIZE, TENURE, AND VALUE OF FARMS

During the period of 1900–1930 the number of farms decreased and their size increased. The depression reversed this trend, with the result that farms were more numerous and smaller in 1940 than in 1930. Improved land in farms has been gradually increasing as more land is cleared of timber or is drained. The proportion of land in farms was highest in 1900; it later declined, owing to the growth of cities, although it rose again in 1940.

Farm data, taken from the United States census reports, are given in table 8.

TABLE 8.—*Rural population and number, proportionate areas, and tenure of farms in La Porte County, Ind.*

Year	Rural population	Farms		Proportion of county in farms	Proportion of farm land improved	Operated by—		
		Number	Average size			Owners	Tenants	Managers
			Acres	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1880	17,424	2,368	122.7	76.3	77.1	78.6	21.4	-------
1890	16,543	2,246	133.0	78.5	79.0	78.3	21.7	-------
1900	16,423	2,613	131.4	95.4	76.1	72.0	26.5	1.5
1910	16,245	2,536	134.3	89.4	78.4	67.5	30.7	1.8
1920	15,828	2,431	139.4	89.0	82.7	64.5	33.8	1.7
1930	18,000	2,135	147.0	82.4	79.7	68.0	30.0	2.0
1940	21,004	2,476	135.1	86.0	80.6	72.3	26.3	1.4

There is a wide difference in the size of farms. Of the 2,476 farms in 1940, 1,185 (almost one-half) included less than 100 acres, 634 ranged from 100 to 174 acres, and 657 included more than 175 acres. Only four farms were larger than 1,000 acres. Most of the small farms are in the vicinity of Michigan City where owners spend part of their time working in factories.

Tenancy gradually increased from 21.4 percent in 1880 to 33.8 percent in 1920 and after that decreased to 26.3 percent in 1940. In 1940, 118 of the 652 tenants rented for cash. The other 534 tenant-

operated farms were rented on a share basis. Under the usual terms, the owner furnishes the farm and pays for one-half of the fertilizer, grass seed, and similar expenses and receives one-half of the crops. The tenant supplies the equipment and labor and pays for his share of the fertilizer, seeds, and other expenditures. On farms where mint is grown, some of the tenants receive one-third of the distilled mint oil.

In 1940 the average value of all property per farm was $9,920. Of this amount 84.2 percent was in land and buildings, 7.6 percent in implements, and 8.2 percent in livestock. Land and buildings alone were valued at $8,350 a farm and $61.81 an acre in 1940. The average value of land and buildings varies widely over the county, and in general the buildings and equipment are well kept. The farms, particularly in the southern two-thirds, are well equipped with modern labor-saving machinery for large-scale operations. About 40 percent of the farms report the use of tractors, 25 percent motortrucks, and 84 percent automobiles.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [7] is determined by simple tests. Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach or bare rocky mountainsides that have no true soil, are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus, Door, Tracy, and Maumee are names of important soil series in this county.

[7] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Tracy loam and Tracy fine sandy loam are soil types within the Tracy series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it usually is the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion frequently are shown as phases. For example, within the normal range of relief for certain soil types, some areas are adapted to the use of machinery and the growth of cultivated crops and others are not. Even though no important differences exist in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, important differences are observed in the growth of cultivated crops. The more sloping parts of such soil types are segregated on the map as a sloping or a hilly phase. Similarly, some soils having differences in stoniness are mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

In La Porte County, 300 aerial photographs covering the entire area were taken from an altitude of 13,500 feet by a single-lens camera on a scale of 4 inches to the mile. The soil map was assembled from small maps made on the aerial photographs. The pictures were covered by clear celluloid material on which the mapping was done without damage to the picture. Such features as roads, houses, streams, and, in many instances, soil boundaries may be traced directly from the picture. All features mapped were first identified by covering the ground by automobile and on foot in such a manner as to see two sides of every 40-acre field. By use of the aerial photograph the boundaries delineating each soil separation could then be shown in their correct location relative to all other features such as roads, fence lines, streams, and trees. Each picture covers an area of about 4½ square miles. After the mapping was completed on the pictures, small maps were reduced to a uniform scale of 2 inches to the mile and assembled in large sheets from which the final colored maps were produced.

SOILS AND CROPS

The soils of La Porte County vary widely in texture, color, acidity, fertility, and moisture conditions. Within a very small area it is possible to find these factors operating to produce a very intricate soil pattern. In general the soils of the county occur in a series of belts that parallel Lake Michigan and the Kankakee River. The agriculture is influenced largely by soil conditions; but economic conditions, particularly the proximity of markets, have modified the system of agriculture.

The surface soils range in texture from heavy plastic silty clays to loose loamy sands and sands. Both the heaviest and the lightest textured soils occur in the northwestern part of the county. Soils with surface layers of loam occupy about half of the total land area. The texture of the subsoils likewise varies. Soils with loose sandy subsoils have a low water-holding capacity, and crops on them may show considerable damage from drought. Soils that have deep moderately heavy textured subsoils, on the other hand, hold moisture well and crops on them can withstand periods of light rainfall.

Most of the soils are easily maintained in good tilth. About 85 percent of them contain enough sand to allow the ready maintenance of a friable consistence. The other 15 percent are silt loams and heavier textured soils that require careful management under proper moisture conditions to keep them in best condition for crop growth.

In color and organic-matter content the soils range from nearly black highly organic (muck and peat) soils to light-colored soils deficient in organic matter. About 8.8 percent of the total area of the county represents organic soils; 47.8 percent dark-colored soils high in organic matter, and 43.4 percent light-colored soils low in organic matter. Originally, the light-colored soils were covered with trees, which had also encroached on the dark-colored marshy soils before the time of settlement; whereas dark-colored soils of the well-drained and imperfectly drained prairie land were developed under a grass cover.

In reaction the soils range from neutral or slightly acid to as highly acid as are any soils in the State. Only a small proportion of the soils are neutral to slightly acid. In the southeastern part of Johnson Township there is an area of soils that are either neutral at the surface or within a foot of the surface. Red clover, sweetclover, and alfalfa may be grown without the use of lime. In the vicinity of Wanatah some of the most acid soils are those in the area of black sandy land known as Hauk Prairie. About 30 percent of the soils are agriculturally sweet (neutral to medium acid) in the subsoil at a depth of 3 feet. The surface soils are predominantly medium to strongly acid over the county and require the application of lime for the growth of legumes.

In no place are the soils developed from consolidated rock; they are formed through weathering processes, from a mixture of gravel, sand, silt, and clay deposited by the Late Wisconsin ice sheet and by water flowing from it. Some of the soils have been developed directly from the ice-laid material, but much of the glacial material was reworked by water or wind before the soils were formed.

Figure 2 is a generalized map of the physiography, surface geology, and soils of La Porte County. In this map three main divisions are indicated—morainic uplands, outwash plains and former lake beds, and flood plains, designated by the capital letters M, P, and A, respectively. Within the first two divisions are several areas indicated by adding arabic numerals to the capital letters M and P.

In area M1 the soils are developed from heavy calcareous till, which in places is covered with a smear of sand varying in thickness from several inches to 4 feet. The Nappanee and Brookston soils are developed very largely from calcareous till alone, although Nappanee loam has a surface soil which was made sandy by a thin layer of sand

deposited on the till. The Allendale and Wauseon soils are both developed in sand smears on clay. In mapping the Allendale and Wauseon soils, it is not always possible to tell whether the underlying clay is till or lacustrine in origin, so that some of the soils in this

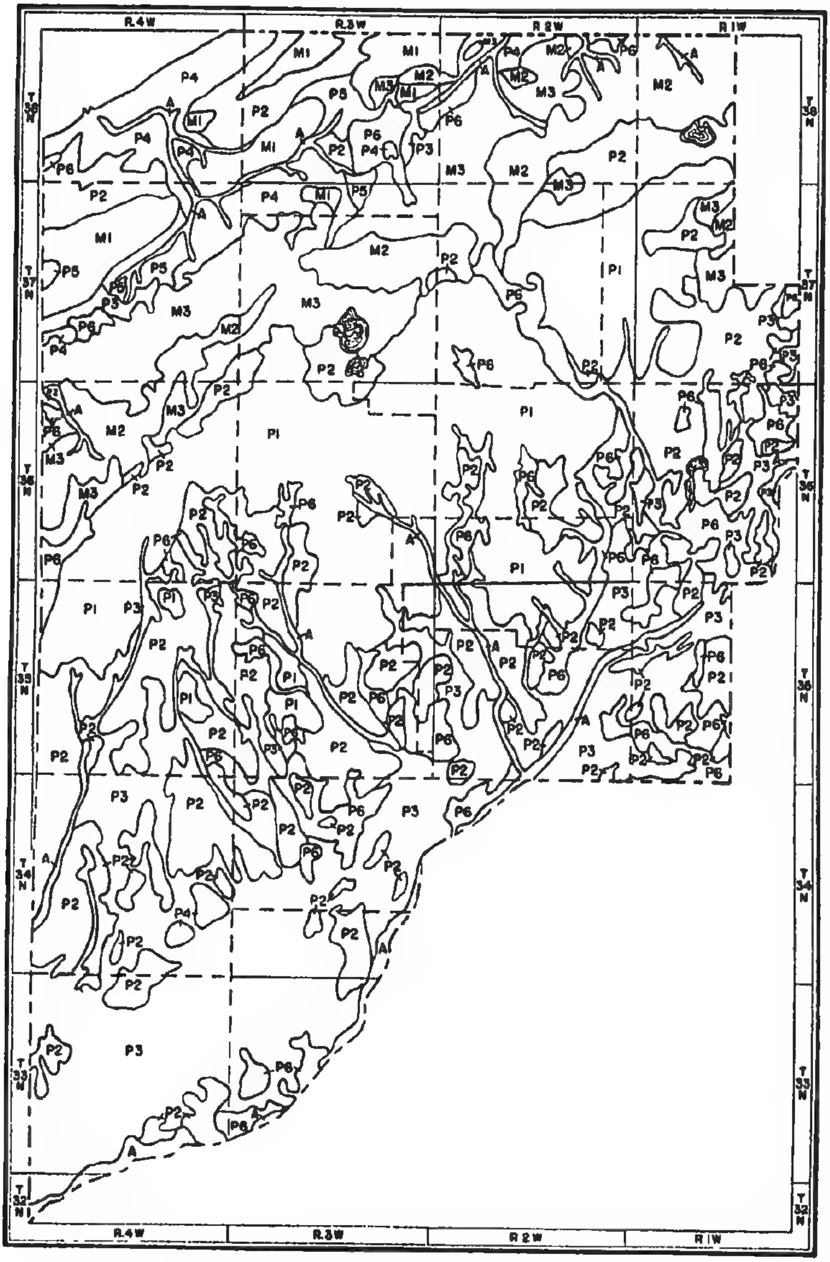

FIGURE 2.—Generalized map of physiography, surface geology, and soils of La Porte County, Ind. Explanation on opposite page.

area may be developed over lacustrine deposits rather than over till. Grain and livestock farming are the principal enterprises followed in this area.

In area M2 the calcareous glacial till is medium to heavy textured but in only a few spots as heavy as in area M1. The content of shale in the till is responsible for the moderately heavy texture. The Galena and Otis soils dominate the area. Grain and dairy farming are the principal enterprises, but the raising of sheep and beef cattle is of some importance.

In area M3 the till is of two types. One type is medium calcareous and sandy in texture, but it also has a moderate content of clay so that it is not excessively droughty. The Hillsdale soils are developed from this kind of till. The second kind of till in this area consists almost entirely of loose sand that has an approximately neutral reaction and contains a few thin irregular seams of sandy clay loam. In many places the till has been reworked into dune-like ridges by the action of the wind. The Coloma soils are developed from this till, and most of them are rather droughty. Grain and livestock farming are the principal enterprises, and there is some specialization in fruit growing. Alfalfa is the most important field crop.

Area P1 of the outwash plains and former lake beds consists of areas of outwash plains in which the material consists of slightly calcareous gravel and sand that has a fairly high proportion of water-washed shale fragments. The soils were developed under a grass vegetation and are darker than the soils of nearby areas developed under forest. The well-drained Door soils and the imperfectly drained Alida soils are underlain by gravel and sand, and the dark-colored Byron soils are developed in smears of almost pure sand on the outwash plain. The dark-colored soils are devoted mainly to corn, wheat, oats, and soybeans, and some dairying is carried on near La Porte.

The soils in area P2 are developed from materials much like those of area P1, but on the well-drained and imperfectly drained soils the original vegetation was forest instead of grass. The well-drained Tracy and imperfectly drained Hanna and Willvale soils were developed from more gravelly material than the somewhat more poorly drained Saugatuck soil and the poorly drained Newton and Maumee soils, which were developed from much more sandy material. The Saugatuck and Newton soils, for the most part, originally were covered with forest, but much of the area of Maumee soils originally

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EXPLANATION OF FIGURE 2

Morainic uplands—(M1), heavy calcareous till, with sand smear in places (Nappanee, Brookston, Allendale, and Wauseon soils); (M2), medium-heavy calcareous till (Galena and Otis soils); (M3), light calcareous and loose-sand tills (Hillsdale soils and Coloma loamy fine sand).

Outwash plains and former lake beds—(P1), slightly calcareous gravel and sand with considerable shale (Door and Alida soils and Byron loamy fine sand); (P2), material similar to P1 but part of it more sandy (Tracy, Hanna, Willvale, Saugatuck, Newton, and Maumee soils); (P3), material similar to P2 but still more sandy in places (Alida, Hanna, Willvale, Newton, and Maumee soils); (P4), water-laid and wind-blown sands with many dunes (Plainfield, Bridgman, and Berrien soils); (P5), slightly calcareous lacustrine deposits of sand, silt, and clay (Lucas, Fulton, and Toledo soils); (P6), muck and peat bogs (Houghton, Carlisle, and Edwards mucks, as well as peat).

Flood plains—(A) recent alluvium and muck (Griffin soils and Kerston muck).

was covered by a marsh type of vegetation. Livestock raising is more important than in area P1 because a large supply of manure is needed to maintain soil fertility.

Area P3 is somewhat like area P2, except that the proportion of sandy material is higher and there is little or no well-drained soil. The proportion of Maumee and Newton soils is much higher. Corn growing is important on the dark-colored soils and small-grain and general farming are more important on the light-colored soils of this area.

Soils of area P4 are developed from water-laid and wind-blown sands, and in many places the landscape consists of ridge after ridge of old dunes that were completely covered by hardwood forest when the county was settled. The Plainfield and Bridgman soils are naturally very rapidly drained; consequently they are droughty for crops. The Berrien soils are imperfectly drained because of a general high water table in the area in which they occur. These droughty soils are not suitable for general farm crops, but they are used to some extent for the production of small fruits, market gardening, and mixed farming. Some alfalfa is grown.

The former lake beds cover the approximate area indicated on the map by P5. The deposits consist of more or less calcareous sand, silt, and clay. The principal soils are members of the Lucas, Fulton, and Toledo series. General farming is the chief enterprise, and some special crops are produced.

P6 on the map indicates the larger areas of muck and peat bogs. Most of these areas are on the outwash plains and in former lake beds, although smaller areas are in the morainic uplands and on the flood plains. The principal soils are Houghton, Carlisle, and Edwards mucks and undifferentiated peat. The drained areas of muck are used for pasture and corn, also for mint, potatoes, onions, and various other special crops.

Area A represents recent alluvium and narrow strips of muck bordering streams. The Griffin soils and Kerston muck occupy all these areas, and the total area is not very large. This land is used largely for pasture and to less extent for corn. Part of the area remains in forest.

The use of much of the land depends largely on the topography. Probably two-thirds of the area of the county represents level to gently undulating plains where water erosion is not a very serious problem. Here, there is little wasteland; and rectangular fields for the use of power machinery are possible. Throughout the rest of the county, which can be classed as rolling, erosion and small or irregular-shaped fields affect the use of the land. The county assessor classifies more than 30 percent of the land in Springfield, Galena, Hudson, Cool Spring, and Lincoln Townships as rough pasture, timberland, and wasteland. All these townships contain large areas of rolling upland, highly dissected terrace lands, or droughty sandy soils. Those townships having the least timberland lie in the Kankakee Basin.

Drainage is another important factor influencing the use of land. About one-third of the land area of the county is or formerly was poorly drained, owing either to a low flat position with a poor natural outlet for the excess water or to a heavy impervious subsoil.

For purposes of discussion the individual soil types and phases are arranged, on the basis of natural drainage and color, in six groups: (1) Light-colored well-drained soils, (2) light-colored imperfectly drained soils, (3) dark-colored well-drained soils, (4) dark-colored poorly drained soils, (5) dark-colored very poorly drained soils, and (6) miscellaneous land types. The very poorly drained soils are subdivided into mineral soils and organic soils. Agricultural practices and farming systems naturally vary from farm to farm, but under similar economic conditions the type of farming most commonly followed is usually determined to a large degree by soil conditions and crop adaptation.

Descriptions of the individual soil types and their crop adaptations are presented in the following pages. The soil map accompanying this report shows the distribution of the soils in the county, and table 9 gives their acreage and proportionate extent.

TABLE 9.—*Acreage and proportionate extent of the soils mapped in La Porte County, Ind.*

Soil type	Acres	Percent
Galena silt loam	10,048	2.6
Galena silt loam, steep phase	1,344	.4
Galena silt loam, eroded phase	384	1
Galena silt loam, gullied phase	192	1
Galena loam	4,544	1 2
Galena loam, slope phase	896	2
Hillsdale loam	7,744	2 0
Hillsdale loam, slope phase	1,216	.3
Hillsdale loam, eroded phase	1,856	5
Hillsdale loam, gullied phase	576	2
Hillsdale fine sandy loam	6,464	1 7
Hillsdale fine sandy loam, slope phase	2,304	6
Tracy loam	21,888	5.7
Tracy loam, slope phase	5,952	1 6
Tracy loam, eroded phase	1,088	3
Tracy fine sandy loam	10,880	2 8
Tracy fine sandy loam, slope phase	5,632	1 5
Tracy loamy fine sand	4,224	1 1
Tracy loamy sand	8,320	2.2
Tracy loamy sand, slope phase	1,472	.4
Coloma loamy fine sand	8,384	2.2
Coloma loamy fine sand, blow-out phase	128	(1)
Plainfield fine sand	10,624	2 8
Plainfield fine sand, rolling phase	2,112	.6
Plainfield fine sand, blow-out phase	704	2
Lucas fine sandy loam	448	1
Bridgman fine sand	1,152	.3
Berrien loamy fine sand	8,448	2 2
Hanna fine sandy loam	6,656	1 7
Hanna loam	3,072	8
Alida fine sandy loam	1,536	.4
Alida loam	1,856	.5
Vaughnsville loam	192	.1
Nappanee silt loam	4,608	1 2
Nappanee loam	1,600	.4
Allendale loamy fine sand	2,624	.7
Otis silt loam	1,728	.5
Otis loam	640	2
Fulton fine sandy loam	576	2
Willvale loam	5,696	1.5
Willvale fine sandy loam	2,880	0 7
Willvale loamy fine sand	1,920	5
Door loam	33,216	8 7
Door fine sandy loam	960	3
Lydick loam	22,144	5 8
Lydick fine sandy loam	2,752	.7
Byron loamy fine sand	3,840	1 0
Brookston silty clay	1,600	.4
Brookston silty clay loam	1,280	3
Washtenaw silt loam	5,120	1.3
Wallkill silt loam	128	(1)
Pinola silt loam	3,904	1.0
Wauseon loam	1,984	.5
Toledo silty clay	384	.1
Granby loam	1,280	3
Granby fine sandy loam	2,112	.6
Griffin loam	3,520	.9
Griffin silty clay loam	2,240	.6
Newton loamy fine sand	12,160	3 2
Newton fine sandy loam	8,384	2 2
Newton loam	8,256	2 2
Saugatuck loamy fine sand	1,472	.4
Maumee loam	27,072	7.1
Maumee fine sandy loam	12,608	3.3
Maumee fine sandy loam, mucky phase	6,400	1 7
Maumee loamy fine sand	17,216	4 5
Maumee clay loam	2,560	.7
Houghton muck	18,688	4 9
Houghton muck, shallow phase over sand	2,944	.8
Houghton muck, shallow phase over clay	1,344	4
Carlisle muck	4,096	1.1
Edwards muck	1,984	.5
Kerston muck	2,688	.7
Peat	1,344	.4
Marl beds	128	(1)
Coastal beach	128	(1)
Pits and dumps	256	.1
Total	380,800	100 0

[1] Less than 0.1 percent.

LIGHT-COLORED WELL-DRAINED SOILS

The light-colored soils developed under a forest cover are uniformly rather low in nitrogen and organic matter. They have only moderate supplies of moisture for the growth of crops, owing either to rolling

relief or to sandy subsoils that are not retentive of moisture. Because of these deficiencies, the soils require rotation of crops and other practices of good soil management in order to maintain or increase crop yields; consequently the system of farming centers around a combination of livestock raising and grain growing, with a large proportion of the land in hay and pasture. Crop adaptations differ widely, according to the soil texture, which ranges from silt loam to fine sand.

The rolling soils of the upland, comprising the Galena and Hillsdale soils, have sufficiently heavy surface soils and subsoils to be suitable for all the general farm crops grown in this county. They are especially suited to grasses and legumes, which are grown on more than one-fourth of the total area of these soils.

The Tracy soils on the outwash plain produce a larger proportion of grain crops, as rectangular fields may be laid out, thus favoring the use of heavy machinery. Because of their acidity, the Tracy soils are not naturally suitable for red clover and alfalfa. Small grains and grasses normally occupy about two-thirds of their cultivated area.

Except where they remain in forest, the light-colored loose sandy soils of the Coloma, Plainfield, Lucas, and Bridgman series are best suited to a mixed system of farming in which fruits and special crops, such as grapes, blackberries, raspberries, some tree fruits, and melons, furnish an important part of the income. Corn and alfalfa are the most extensively grown field crops. As they have deep root systems, these crops are able to obtain moisture from the subsoil, and thus overcome to some extent the ill effects of the low moisture-holding capacity of the soils. From 20 to 30 percent of this land is normally idle or in pasture.

Galena silt loam.—Galena silt loam is the most extensive soil of the well-drained uplands. It occurs as an almost continuous strip from ½ to 3 miles wide on the main divide, the widest part being in the northeastern corner of the county. Most of the areas are fairly large and include a few minor soils. The topography is that of a gently rolling glacial till plain broken by numerous kettle holes and depressions.

In cultivated fields the 7- to 9-inch surface soil is grayish brown and has a loose granular structure. The supply of organic matter is low, but the material is finely divided and well distributed. Although the content of sand is low in this layer, the granular structure is easily maintained. The subsoil, which reaches to a depth of 20 inches, is yellowish-brown silty clay loam with gray and yellow mottling at a lower depth. The limy yellowish-gray parent glacial till is of Late Wisconsin origin, and consists of mixed silt, clay, sand, and gravel. This material occurs at an average depth of 5 feet, but in places the depth is as little as 3 and in others as much as 6 feet. Sufficient coarse material is present to cause the soil to crush easily when moist. When dry, the subsoil becomes hard and compact.

The relief ranges from rolling to undulating. In flatter areas, the soil has a brownish-gray surface layer and a light-gray subsurface layer. This condition is due to slightly impaired internal drainage caused by the heavy-textured subsoil, and it is a transitional condition between the Galena and the Otis soils.

About 20 percent of this land is devoted to corn, a use that promotes rapid runoff on the more sloping areas and results in considerable erosion. The growth of small grain and grasses retards erosion and rapid depletion of the normally low supplies of organic matter. About 25 percent of the land is used for small grains, and 40 percent for pasture and meadows. The following 5-year crop rotation is usually practiced: First year, corn; second year, oats or soybeans; third year, wheat; and fourth and fifth years, clover and timothy or mixed hay. The large proportion of grass aids materially in reducing erosion and in maintaining the organic content and fertility level. Much of the pasture is on the sloping areas that are most susceptible to erosion.

Galena silt loam is a moderately productive soil. It is more abundantly supplied with plant nutrients than most of the sandy soils of the county, but it lacks the abundant moisture supplies of the poorly drained dark-colored soils. It is moderately acid to a depth of about 40 inches, but at a lower depth lime is abundant. Applications of lime are necessary for the growth of alfalfa and sweetclover, and in most places lime would be beneficial for red clover. Many farmers report that the use of available supplies of manure on the wheat results in good stands of clover, which follows wheat in the rotation.

Although corn is not so well adapted to the light-colored soils as it is to the dark-colored soils, it is grown in rotation with other crops. Most of it is grown without fertilizer, the yields ranging from 25 to 35 bushels an acre. Manure is used when available and the use of commercial fertilizer is increasing. The fertilizer most frequently used is 2–12–6 in applications of 65 to 100 pounds an acre. Yields are frequently reduced by drought. Oats are not widely grown because yields are reduced by the midsummer drought. Soybeans are largely replacing oats, both as a hay crop and as a seed crop.

Wheat, a cash-grain crop, occupies a slightly less important place in the farming system than corn. It is well adapted, and yields range from 17 to 25 bushels an acre. It is seeded in the fall, following oats or soybeans, or in the standing corn. The greatest moisture requirement of this crop is in the spring when the supply is adequate. Manure is applied when available. Commercial fertilizer analyzing 2–12–6 is widely used, generally at the rate of 100 to 150 pounds an acre.

Red clover and mixed clover and timothy are important crops in the rotation, although the average yields of clover are reduced by occasional crop failure, owing to soil acidity and drought. In the northeastern part of the county, some clover is harvested for seed, yielding from 1 to 2 bushels an acre.

In common with other Galena soils about 10 percent of Galena silt loam is used for bluegrass pasture. This is due to a number of factors, such as the natural adaptation of the soil to grass, the rolling topography and erodibility under cultivation, and the greater distances from Chicago. Pastures are used mainly for dairy cattle in the western part of the county, but in the northeastern part a considerable number of sheep and beef cattle are fattened. Some pastures are overgrazed, particularly in the northeastern part. This is resulting in destruction of the pastures by sheet and gully erosion.

Galena silt loam, steep phase.—Galena silt loam, steep phase, is similar to Galena silt loam. Long narrow strips of this soil border drainageways or surround deep kettle holes on slopes that range from 15 to 30 percent and that are too steep for normal farming operations; consequently the soil is used mainly for forestry and pasture. Only a small area is mapped. Under a timber cover the upper 8-inch layer of soil has a moderately dark-brown color imparted by accumulated organic matter. This layer is underlain to a depth of 11 inches by yellowish-gray smooth silt loam. Under cultivation the dark surface layer mixes with the soil beneath.

The present forest cover consists of second-growth, tie-size, and mixed hardwoods. The principal varieties of trees are sugar maple (whence comes the local name of sugar-tree land), beech, ash, shellbark hickory, American elm, and white oak.

Cleared areas of this soil are suitable for pasture provided they are not overgrazed. Under cultivation, the loss of soil by erosion is rapid, and as crop yields decline, the land is eventually returned to pasture or timber.

Galena silt loam, eroded phase.—The profile of Galena silt loam, eroded phase, originally was much like that of normal Galena silt loam, except that the depth to calcareous glacial till was somewhat less. This soil occurs on slopes of 15 to 30 percent and differs from the steep phase in that it has been cleared and cultivated and has lost practically all of its original surface soil through erosion. It has little or no value for cultivated crops and should be reforested or seeded to pasture plants.

Galena silt loam, gullied phase.—Galena silt loam, gullied phase, like the steep and eroded phases, occurs on slopes of 15 to 30 percent. Like those soils, too, it originally had a profile much like that of the normal soil. Now, however, it has lost most of its surface soil through erosion. In addition it has been cut by so many shallow and deep gullies that it cannot be used economically for cultivated crops or pasture. It should be reforested.

Galena loam.—Galena loam differs from Galena silt loam principally in the texture of the surface soil, which contains sufficient coarse material to keep the soil in a friable condition favorable for crop growth. Pastures on this soil withstand trampling of livestock well, but they are not so productive as those on the heavier soils. The yellowish-gray mellow plow soil absorbs rainfall readily. The subsoil to a depth of 15 inches generally is friable, but the deeper soil material consists of yellowish-brown heavy silty clay loam that is hard when dry. At a depth of 5 feet this rests on the parent material, which in most places consists of limy rather heavy glacial till, but northwest of Westville some large areas of this soil have distinctly more friable and gritty and much less limy substrata. Flatter areas of this soil occur throughout the rolling hill land, associated in many places with areas of the Hillsdale soils. The crops grown and the yields obtained are similar to those on Galena silt loam, although the returns are somewhat less.

Galena loam, slope phase.—A small area of Galena loam, slope phase, is mapped. The land is too steep for permanent successful cultivation. Like the steep phase of Galena silt loam, it occurs

around kettle holes and valley walls, in association with the typical soil from which it differs mainly in slope. The land is used principally for pasture and timber.

Hillsdale loam.—Hillsdale loam is probably the second most important soil of the dairy, livestock, and grain-farming sections. As it is developed from more sandy lighter textured materials, it occurs on the borders of the group of heavier Galena soils and the loose sandy Coloma soils. The land is rolling, and the ridges are broken by numerous kettle holes and shallow depressions. In a few areas, such as that north of Durham, the land is strongly rolling to hilly.

The plow soil is brown or grayish brown, indicating excellent drainage. It ranges in texture from heavy to light loam. The sand content is adequate to insure good tilth under all conditions. Although the soil crumbles easily under slight pressure, enough clay is present and well distributed through the soil mass to create a mellow granular structure. This soil withstands considerably more abuse from pasturing and tillage than Galena silt loam. It is open and porous. The organic-matter content is low.

The subsoil to a depth of 18 inches is moderately heavy clay loam or sandy clay loam. It is brownish yellow or yellow with slight variations here and there owing to iron stains, but not those induced by poor drainage. Below a depth of 3 feet the subsoil is more friable and sandy, and it is underlain by mixed silt, shale, and gravel. The sand content, heavy texture, and thickness of the subsoil and sandy character of the substratum result in a lower moisture-holding capacity than that of the Galena soils, thereby producing slightly lower yields of such crops as corn. Small grains and grasses, which mature early, are well adapted. Soybeans are widely grown, principally for hay, with yields averaging between 1½ to 2 tons an acre.

The organic-matter content of Hillsdale loam is maintained by keeping a large proportion of the land in meadow and pasture. Sheet erosion is very severe when the bare soil is exposed; consequently on well-managed farms a grass cover generally is kept on the slopes. Apples, pears, and peaches are grown to some extent on areas that have suitable air drainage. The Michigan Agricultural Experiment Station reports (*13*) that on slopes of 7 percent, erosion results in serious loss of fertility in peach orchards, but this land can be used for tree fruits by the use of remedial measures, such as sod stripping and planting and cultivating on the contour. It is also feasible to grow peaches under a sod mulch. Apple orchards can be kept in short sod rotation or in permanent sod.

Despite deficiency in moisture, the fertility of Hillsdale loam about equals that of Galena silt loam. The reaction is medium to slightly acid in the upper part of the soil.

Hillsdale loam, slope phase.—Hillsdale loam, slope phase, occurs in widely scattered small areas on the steeper slopes of kettle holes and stream valleys of the moraine, especially in Cool Spring Township. Like the steep phase and slope phase of the Galena soils, this soil occurs on slopes—15 to 25 percent—that are too steep to farm successfully. Most of the land has a cover of timber, which is all second growth. The principal species of trees are sugar maple, beech, ash, American elm, basswood or linn, black oak, red oak, shellbark hickory, gum, and walnut.

Hillsdale loam, eroded phase.—Small bodies of Hillsdale loam, eroded phase, are scattered throughout the uplands. Erosion is a serious problem on slopes of almost any degree in the Hillsdale soils, as the loss of surface soil quickly reduces the fertility. Under cultivation practically all of the sloping land takes on the yellow color of the subsoil as the grayish-brown finer textured plow soil washes away. The coarse material that is left consists of sand, shale, and gravel in varying proportions. The resulting texture varies in very small areas from gravelly loam to clay loam. The subsoil features and characteristics of this soil are similar to those of Hillsdale loam.

Most of the slopes with gradients of 5 to 15 percent are or have been under cultivation. Erosion has removed much of the surface soil, leaving the land very low in organic matter and plant nutrients. A few small areas of eroded Galena soils are included with this soil, but they are even less desirable for the growth of crops because the subsoil is heavier textured and slightly more acid in reaction.

Hillsdale loam, gullied phase.—Gully erosion is not so common as sheet erosion, but many very small areas of Hillsdale loam, totaling only 576 acres, have been destroyed by gullies. This gullied land is associated mainly with the Hillsdale soils and, to less extent, with the Galena soils. The Hillsdale soils have clay loam subsoils underlain by loose gravel and sand at a depth of 60 inches. When gullies once penetrate the clay loam subsoil, they undercut and enlarge rapidly, making wide deep gullies in a short time; they are, therefore, difficult to control. Gullies are more common and more destructive in the Hillsdale soils than in the Galena soils, which have a heavy-textured subsoil.

As most of the gullies are too deep to be crossed by tillage implements, the areas are used as rough pasture land or are wasteland. Some attempts have been made to control the gullies by filling them with junk and brush, and by building dams, but these measures have been rather ineffective because of the undercutting type of erosion, which widens as well as lengthens and deepens the gullies.

Hillsdale fine sandy loam.—Hillsdale fine sandy loam occurs in a few large areas northeast and northwest of La Porte and in scattered small areas associated with Hillsdale loam and Coloma loamy fine sand. Where associated with Coloma loamy fine sand, it occurs on the hillsides as spots of clayey till ranging in thickness from a few inches to 20 inches, with a thin covering of loamy fine sand. The spots with a clayey subsoil have a strong yellowish-brown color. The land is a little more rolling than Hillsdale loam. Elsewhere the brown or grayish-brown plow soil is fine sandy loam or sandy loam, containing some medium and coarse particles. Rainfall is quickly absorbed so that sheet erosion is not serious, except during torrential rains. The organic-matter content is low. Tilth conditions are always good.

Hillsdale fine sandy loam, slope phase.—This soil is associated with and is similar to typical Hillsdale fine sandy loam, except for its occurrence on nonarable slopes. A small area is mapped, most of which is covered by second-growth hardwood forest but some of which is used for pasture.

Tracy loam.—This soil is one of the most extensive in the county, occupying 21,888 acres. It was originally timbered, but was soon formed by wind action. Kettle holes of varying depth and number

the pioneers. About 90 percent of it is now cropped. Typically, the areas are nearly flat to undulating, and they border streams and small lakes or beds of muck on the outwash plains. The largest areas lie along an imaginary line extending from a point east of Union Mills past Door Village to Pinelake, thence northeastward past Rolling Prairie to Hudson Lake. Areas are between Stillwell and Hudson Lake. Those areas bordering the uplands, particularly those east and northeast of Rolling Prairie, are more undulating than elsewhere and, in many places, are highly pitted. Local differences in elevation are as much as 50 feet or even more. Some areas of this plain are nearly as high as the rolling uplands.

The plow soil of cultivated fields is grayish brown and comparatively low in organic matter. The silt loam plow soil contains sufficient sand to give it a friable or mellow physical condition. The subsoil to a depth of 30 inches is yellowish-brown moderately heavy clay loam that becomes hard when dry. It contains enough finer material to cause it to retain sufficient moisture to mature crops in most years. When moist, the subsoil material breaks into angular particles that favor aeration and drainage. Between average depths of 30 and 50 inches the subsoil consists of strong yellowish-brown loose clayey sand that is moderately retentive of moisture. At a lower depth, the material consists of layers of loose sand, which contain variable quantities of gravel and fragments of shale, and layers of finer sediments, which in places contain some lime at a depth of 6 feet or more.

The soil is strongly acid throughout; consequently many legumes, such as the clovers or alfalfa, cannot be grown without the use of lime. As much of this soil has not been limed, the acreage devoted to soybeans as a leguminous hay crop is gradually increasing. Corn, oats, wheat, timothy, and redtop are usually grown in rotation. Where lime has been applied, red clover may be grown, although drought frequently kills it. Even though corn yields are considerably lower than on the dark-colored poorly drained soils with their greater supplies of organic matter and moisture, the system of farming requires that more than one-fourth of the land be used for corn in order to produce sufficient feed for livestock. Yields of corn average about 35 bushels an acre. It is a common practice to let the land lie idle 1 or more years immediately following grass or small grain, in order to increase the organic-matter content and fertility. Oats, because of low yields, ordinarily are not grown except in small acreages for horse feed. Soybeans are replacing oats to some extent because of their resistance to drought, their ability to grow on acid soil, and the need for a leguminous hay crop. Most of the available supplies of manure are used and in addition an application of 100 to 150 pounds of commercial fertilizer to the acre is generally used on the wheatland. Cornland is manured and fertilized to a less extent. This soil is well adapted to the growth of wheat, yields of which normally range from 15 to 20 bushels an acre.

Tracy loam, slope phase.—This soil occurs on narrow slopes bordering streams and kettle holes throughout the outwash plains. It differs primarily in topography from typical Tracy loam, which occupies flat to undulating areas. The narrow slopes, ranging from 10 to 25 percent gradient, are in most places not too steep to farm. As the slopes are generally less than 15 feet, tillage operations are

performed in many places across the slope. Probably more than one-half of this land is farmed. Most of the steeper, wider slopes, occurring in the areas of greatest relief, are kept in timber. In areas associated with areas of Lydick loam, the surface soil generally is darker and is richer in organic matter and nitrogen than in areas associated with Tracy loam. Although originally forested, most of this soil has been cleared and is now used for grain and meadow crops or pastures. Crop yields are lower than on the less rolling land, because erosion is active and because the supply of moisture is more limited due to greater runoff.

Tracy loam, eroded phase.—Cultivated slopes of the Tracy soils are susceptible to severe sheet erosion. The light-brown plow soil generally is less than 6 inches thick, but in many places it has been removed entirely, exposing the yellowish-brown moderately compact acid subsoil. On eroding slopes the finer particles of silt and clay are removed more rapidly, leaving a residue of gravel and shale. Erosion is more severe on the long steep slopes where relief and stream dissection are greatest. Actual removal of soil is less severe on the sloping prairie, but reduction in the yield of crops is greater because the slopes are more intensively cultivated. Only a small area is mapped, most of it south of Sogganee Lake. A few shallow gullies occur in places.

Reduction in yields of crops depends largely on the extent to which the plow soil has been removed. Yields of corn are most noticeably affected by erosion. They range from 5 to 20 bushels an acre. In dry years the crop may be a complete failure. Yields of wheat, generally ranging from 5 to 12 bushels an acre, are not reduced so much by drought because moisture is adequate in the early summer.

Tracy loam, eroded phase, includes a few small areas of Tracy loam in which small shoestring gullies have not been controlled and have finally cut through the heavy subsoil into the loose sandy substrata. On steep slopes a caving, undercutting type of erosion has widened and elongated the gullies until it is impossible to control them except through engineering methods. In the early stages gullies may easily be controlled by brush dams and locust or other types of tree plantings.

Tracy fine sandy loam.—Fairly large areas of Tracy fine sandy loam lie near the boundary between the higher terraces and the Kankakee River marsh. This soil occurs in the same general localities as Tracy loam, but it is more closely associated with the more sandy Tracy soils. One large isolated area is in the vicinity of Durham. The surface generally is more undulating than that of Tracy loam.

This soil is similar to Tracy loam except that the surface and subsurface layers, to a depth of 15 inches or more, contain a higher proportion of sand and are mellow and easily tilled. The grayish-brown plow soil absorbs moisture more readily, but, owing to its well-aerated open condition, the organic-matter content is lower and the soil dries out more readily, making crops more susceptible to injury from drought. The yellowish-brown clay loam subsoil is more friable and contains slightly less fine material than the subsoil of Tracy loam, so that the moisture-holding capacity is lower.

As moisture conditions are somewhat less favorable, average yields of corn and oats are slightly lower than on Tracy loam. It is also

more difficult to maintain good stands of clover than on that soil. The agriculture in other respects is similar to the agriculture practiced on Tracy loam, except that there is greater need to increase the organic-matter content and in other ways to overcome the moisture deficiencies of the soil.

Tracy fine sandy loam, slope phase.—This soil differs from typical Tracy fine sandy loam only in the degree of slope, which ranges from 8 to 25 percent. Those areas associated with areas of the Prairie soils have a slightly darker color and higher proportion of organic matter than elsewhere. Most of the areas are on the high terraces in the eastern part of the county and along the southern border of the outwash plain. The slope is a little steeper than that of Hillsdale loam, slope phase; consequently a larger proportion of the land is used for woods or pasture.

Tracy loamy fine sand.—Tracy loamy fine sand is developed from the sandy material of the outwash plain, which contains enough shale and other clay-forming material to bind the sand particles to a variable extent and also to impart a brownish-yellow color to the soil. As this soil has slightly greater moisture-holding capacity than Plainfield fine sand and occurs at a greater distance from markets, a grain-and-livestock system of farming is followed. Few special crops are grown.

Small scattered areas of this soil border the Kankakee River marsh. The larger bodies are north of Rolling Prairie, northwest of Mill Creek, and in the vicinity of Tracy, Hanna, and Wanatah. The land is gently undulating.

The surface soil to a depth of 12 inches consists of grayish-yellow or slightly brownish yellow loamy fine sand, with a thin clay coating on the sand particles sufficient to give some coherence to the soil mass in the moist condition. When dry this plow soil seems like loose mellow fine sand. The underlying material consists of strata of grayish-yellow and brownish-yellow loose fine sand containing a few seams of clayey sand or sandy clay loam.

This soil is intermediate in moisture-holding capacity, organic-matter content, and fertility level between Plainfield fine sand and Tracy fine sandy loam. Although about the same proportion of all crops adapted to the county are grown as on Tracy fine sandy loam, deep-rooted and drought-resistant crops have a more important place in the farming system. Crop adaptations and yields are similar to those described for Tracy fine sandy loam except that drought-resistant crops are somewhat better adapted.

Tracy loamy sand.—Tracy loamy sand is developed from water-laid deposits of sand containing a few strata of finer textured silt or fine gravel. In places the land is undulating to gently rolling, owing to the presence of a few sand dunes. Wind shifting and assortment of the surface soil is constantly taking place. The plow soil is yellow and contains scarcely enough organic matter to give it a somewhat brown tint. The soil particles cohere slightly, because they are covered with a thin film of organic and colloidal matter. The subsoil below a depth of 12 inches consists of yellow loose loamy sand. Some finely divided shale and seams or pockets of loam or sandy clay loam material occur at a depth of 2 feet or more. In most

places the surface soil consists of well-assorted sand, but pieces of nonlimy shale and sandstone gravel are present in places throughout the soil. Generally, the entire soil is strongly acid, but here and there a few strata and pockets of low-lime gravel or finer material occur below a depth of 6 feet.

The soil mapped as Tracy loamy sand in the Lake Michigan Basin in the northern part of the county in reality is Plainfield loamy fine sand, but it was not separated when the county was mapped. Plainfield loamy fine sand is somewhat more droughty than Tracy loamy sand because the streaks of loamy material are less abundant in the subsoil.

Because of the small quantity of fine-textured material and the very low organic content, yields of most crops are reduced by inadequate moisture. All the farm crops adapted to the region are grown on this soil, although corn and drought-resistant crops, such as soybeans, alfalfa, and sweetclover, are best adapted. As most of the crops grown are fed to livestock, corn is an important crop in the farming system, occupying about 30 percent of the land. Yields are low, probably averaging about 15 to 25 bushels an acre. It is a common practice to allow grainfields to lie idle 1 to 3 years before planting corn on them. Soybeans are grown for seed on many farms and also as a leguminous hay crop. About 10 percent of the land is used for this crop. When planted for seed, the beans are drilled in rows and cultivated during the summer. Yields range from 10 to 25 bushels an acre. The value of application of 2 tons of ground limestone an acre on this soil is being recognized more widely in recent years. Sweetclover and alfalfa cannot be grown without it, but both make excellent response when lime has been added.

This soil occurs in rather large areas in the vicinity of Hanna, Tracy, and Mill Creek bordering the former Kankakee River marsh.

Tracy loamy sand, slope phase.—This soil differs from typical Tracy loamy sand principally in slope. Most areas have slopes of 10 to 25 percent bordering streams and beds of muck, but a few areas have a rolling dune configuration, the axis of the dunes generally extending in a northwest-southeast direction. A small total area is mapped, mostly in the vicinity of Hanna. Most of the steeper areas are used for timber or pasture. Field crops are grown on about 50 percent of this soil. The crops are similar to those grown on the typical soil, but yields are somewhat less. The soil is subject to erosion by water during torrential rains and by wind where there is no vegetative cover.

Coloma loamy fine sand.—Of the light-colored well-drained loose sandy soils, Coloma loamy fine sand is probably the most important from the point of view of crop adaptation and variety and value of crops grown. It occurs in a narrow strip ranging from ½ to 2½ miles in width, extending northeastward from Beadest Corners, through Hatch Mills, and in large areas with some of the Hillsdale soils and organic soils mixed through it.

This soil is developed from ice-laid sand containing a small quantity of gravel. The land is rolling, with some ridges and depressions formed by wind action. Kettle holes of varying depth and number

occur. As this sandy soil has an open permeable structure, moisture and air move very freely through it and drainage is excessive.

The surface soil consists of grayish-yellow loose slightly coherent loamy fine sand that is subject to some wind assorting and erosion. The organic-matter content always has been very low, even under the original forest cover. The subsoil consists of yellow loose fine sand to a depth of 3 to 8 feet or more. Some gravel and coarse sand are present in places throughout the soil mass, and pockets of calcareous gravel are common below a depth of 5 feet. To a depth of 3 feet the soil is moderately acid, but below this it generally is neutral to slightly alkaline.

Because of the moderate acidity and the excellent drainage and aeration, the soil is naturally suitable for alfalfa and sweetclover, although it is necessary to apply sufficient lime to neutralize the acidity of the plow soil. A higher proportion of alfalfa is grown on this soil than on any other soil in the county. About 90 percent of this land originally was cleared and brought under cultivation. Now about 30 percent of it is idle because of low crop yields. A large proportion of the acreage of small grains consists of rye which is betted adapted to the sandy soils. In some places wind erosion destroys small-grain crops on the sandy soils. Wheat and rye yield from 8 to 15 bushels an acre. Yields of corn vary widely, depending on the rainfall; they average about 20 bushels an acre.

Coloma loamy fine sand is more extensively used for fruits and special crops than any other soil in the county. It is estimated that 14 percent of the land is used for special crops, of which grapes are the most important. Farmers report that it is well suited to all the tree fruits and small fruits including grapes, blackberries, raspberries, and melons. Apples and peaches are grown most successfully on the Coloma and associated Hillsdale soils, on carefully located sites having a northern exposure and good air drainage. The failure of many orchard enterprises has been due primarily to poor location.

Vineyards are most intensively developed on this soil northwest of La Porte. Yields of grapes as high as 200 bushels an acre are reported. The chief soil-management practice is the use of rye as a fall-seeded cover and green-manure crop, in order to prevent soil blowing and to build up and maintain the organic-matter content and conserve moisture supplies. The vineyards are cultivated during the summer. As the soil is very deficient in nitrogen, occasional applications of nitrate of soda are made. Complete commercial fertilizers are not used to a great extent. Spraying is usually needed to control dry rot. Melons, blackberries, and raspberries are special crops that are well adapted to the loose sandy soils.

Coloma loamy fine sand, blow-out phase.—This soil is mapped within small scattered areas of the Coloma soils where the wind is actively moving the loose sand. Most of these areas occur on exposed knolls that have been cleared of trees and brought under cultivation. In the absence of a vegetative ground cover, the loose sand may be easily shifted by the wind, which is very active in this part of the State. Areas of this soil are marked by irregular holes that are as much as 3 feet deep. Farmers report that it is practically impossible to grow crops on such areas. Small grains, even when topdressed with manure, are reported to be blown out by the roots.

Plainfield fine sand.—Although a few small areas are on the southwestern extremity of the outwash plain, Plainfield fine sand occurs chiefly and typically in the Lake Michigan Basin in the northwestern part of the county. Behind the belt of high dunes bordering the lake, it occupies four nearly continuous strips paralleling Lake Michigan. Three of these strips are narrow beachlike areas and the fourth is a broad area filling the abandoned valley of glacial Trail Creek and extending through Michigan City. Between these strips it occurs as isolated ridges and swells projecting from the adjoining marshlands. The land is undulating to gently rolling, and the ridges are rounded and dune shaped. A fairly large area is mapped.

This soil is formed from stratified water-laid fine sand that has been subsequently reworked and assorted by the wind. Insufficient clay-forming minerals are present in the parent material for the development of heavy-textured subsoils; consequently the soil mass consists of loose sand having very low moisture-holding capacity. In cultivated fields, the soil has a yellow or grayish-yellow color. In wooded areas the upper 3-inch layer is darkened by accumulated organic matter, but in cultivated fields only enough organic material remains to give the surface soil a slightly brownish yellow cast. The subsoil consists of yellow or pale-brown loose fine sand that is strongly acid throughout. The extensive areas of this soil along Trail Creek may contain small quantities of cherty gravel in a few places.

Several variations from this typical profile are included in this mapping. On the inner border of the high dunes along Lake Michigan, timbered low dune areas of this soil had a thin layer of light-gray sand just below the dark organic surface soil, underlain by a layer of brownish-yellow loamy fine sand just above the yellow subsoil. Under cultivation the material in these layers is quickly disseminated. An area in the vicinity of Waterford has a yellow or brownish-yellow surface soil that extends to a depth of 2 feet. It has more organic matter than the typical soil, a film of clay surrounding the sand particles, and, consequently, a slight coherence that is lacking in the typical soil. Crops appear to be more productive on this included soil. Another variation has a strong-brown color to a depth of 24 inches or more. When dry the subsoil in this variation is slightly cemented with oxide of iron.

With the exception of the higher acidity and the slightly more open permeable character of this soil, it is similar to Coloma loamy fine sand. The agriculture is similar on both soils, and most of the field crops grown are fed to work animals, chickens, and small herds of dairy cows. The tree fruits generally are not very productive on this soil, and only small acreages are devoted to these crops. Grapes grown on this soil equal those grown on the Coloma soils both in quality and quantity. Market gardening is an important source of income, partly because of the smaller farms and their proximity to the cities. About 80 percent of this soil is under cultivation.

Plainfield fine sand, rolling phase.—This soil occupies rolling rounded narrow ridges associated with typical Plainfield fine sand. It also occupies steep slopes bordering drainageways. The total area is not large. About 70 percent of the land has been cleared and is under cultivation. Since it occupies prominent locations, it is more

exposed to wind erosion where cleared. It also is a little more deficient in moisture than the less rolling members of the series. Crops grown and yields are similar to those of the typical soil. A higher proportion of the cleared land is idle, compared with that soil.

Plainfield fine sand, blow-out phase.—A small area of Plainfield fine sand has been subjected to destructive wind erosion resulting in loss of the loose sandy surface soil and the formation of pits several feet deep in the subsoil. These areas are most common in the vicinity of Michigan City. As they are unsuited for agriculture, most of them represent wasteland.

Lucas fine sandy loam.—Lucas fine sandy loam is an inextensive soil occurring along stream banks in small lake plains south and north of Waterford and in the vicinity of Springfield. It is developed from moderately calcareous sand and silt deposits laid down by glacial lake waters and exposed when the lakes disappeared. The land is undulating to very gently rolling.

The plow soil is brownish-yellow or yellow fine sandy loam to a depth of 12 inches. In a few places the material has been assorted by the wind, and the surface soil consists of deeper more mellow loamy fine sand than elsewhere. The subsoil, which reaches to a depth of 20 inches is yellow light clay loam, which becomes heavier textured with depth and is mottled with gray at a depth of 30 inches. The higher proportion of fine-textured material in this soil greatly increases the moisture-holding capacity over that of the very sandy soils with sand substrata. The underlying layers consist of stratified sand, silt, and clay, which, at a depth of 40 to 80 inches, are limy. Above the parent material the soil is strongly acid.

In the vicinity of Springville about 40 acres of a heavier textured member of this series is included with this separation. Here the surface soil is grayish-brown silt loam, and it is underlain by a yellow or yellowish-brown silty clay loam subsoil. The limy subsoil lies 40 inches below the surface. Owing to their greater moisture-holding capacity, the Lucas soils are suitable for general field crops and the sandy areas are also adapted to grapes and other small fruits.

Bridgman fine sand.—Bridgman fine sand forms a belt of wooded dunes bordering as strip of coastal beach along Lake Michigan. The series of ridges paralleling the lake are high on the inner and outer borders, but depressions and troughs are common in the interior. Large blow-outs or areas of bare shifting sand border the lake. With a few exceptions, the interior ridges of the dunes are well timbered.

Bridgman fine sand represents wind-blown sand deposits having very little development of a soil profile. Many of the lower inner ridges border areas of the Plainfield soils, from which they have been somewhat arbitrarily separated. Under a forest cover the loose sand has a dark-gray layer of partly decomposed leafmold 2 inches or more thick. A thin layer of light-gray fine sand about one-half inch thick is underlain to a depth of 20 inches by pale-yellow loose fine sand. At a lower depth the sand is pale yellowish gray. The gray blow sand bordering the lake is alkaline in reaction and in places is slightly calcareous. Farther away from the lake the soil is more acid and the subsoil more yellow, compared with the soil near the lake.

These dunes have little agricultural value because they have a low moisture-holding capacity. When cleared of timber, the loose fine

sand is susceptible to severe wind erosion. Most of the merchantable timber has been cut, leaving a scrubby growth of black oak and white oak. The recreational possibilities of this section have resulted in rapid development of the dune belt for permanent residence and as a summer resort.

LIGHT-COLORED IMPERFECTLY DRAINED SOILS

The soils of this group are intermediate in natural drainage conditions between the well-drained and the poorly drained soils, and they are all light-colored.

The Berrien, Hanna, Alida, and Vaughnsville soils occur throughout the sand plains of the Lake Michigan Basin on the more sandy knolls and swells near the Kankakee River. The organic-matter content generally is low but not so low as in the other members of this group. The brown or grayish-brown surface soils are underlain by yellow subsoils. At a depth of 20 to 24 inches, imperfection in drainage is shown by the gray and yellow mottled color. These soils occupy a higher position than the poorly drained soils; consequently they are not so quickly saturated by heavy precipitation and crops do not suffer so readily. A system of grain and livestock farming usually is followed. All these soils are developed from acid stratified sand and silt deposits.

The Nappanee, Allendale, Otis, Fulton, and Willvale soils are less well drained than those mentioned above, but crops can be grown on them, although with some difficulty, without artificial drainage. For this reason they are not classed as poorly drained, even though artificial drainage is very desirable.

They occur in comparatively small areas scattered throughout the county. They are characterized by gray or grayish-brown surface soils and mottled gray and yellow subsoils. All these soils have been developed under a forest cover and under conditions of periodic saturation with moisture. The land is flat in most places. Slow internal drainage is due to heavy impervious subsoils, and most of the members of the group occupy low positions where they naturally have a high water table or ground water level. They are low in organic matter and nitrogen, moderately to strongly acid, and deficient in plant nutrients, particularly phosphorus. In the heavier textured soils the surface soil puddles and bakes badly; consequently physical conditions are unfavorable for the growth of crops. Dairying and livestock raising are best developed on the soils of the heavy till because of the greater proportion of pasture and hay available.

Berrien loamy fine sand.—Berrien loamy fine sand, the most extensive of the imperfectly drained sandy soils, occupies low flats, surrounded by droughty Plainfield soils, and swells or low ridges, surrounded by the former marshes of Newton and Maumee soils.

The 9-inch surface soil of grayish-brown loose loamy fine sand is underlain by yellow fine sand to an average depth of 22 inches. At this depth the sand is periodically saturated with moisture, so that it has developed gray and yellow mottles or rusty iron stains. The underlying fine sand is gray to yellowish gray. Strata of very fine and coarse sand are common, and in a few places gravel is scattered

through the soil. Assorted by the wind, uniformly fine sand extends to a depth of 3 feet or more.

Although most of the crops adapted to the region are grown, yields are below average, owing to the low supplies of organic matter, nitrogen, and other plant nutrients. The soil is so strongly acid that alfalfa and sweetclover cannot be grown satisfactorily without the use of lime. Corn, rye, and soybeans are the principal field crops. Oats are rarely grown because they do not yield well under the droughty conditions that prevail in summer. In the northern part of the county truck crops, blackberries, raspberries, and grapes are grown. The agricultural practices on associated soils usually influence the cropping system, especially where the areas of this soil are small.

Hanna fine sandy loam.—Hanna fine sandy loam differs from Berrien loamy fine sand principally in being formed from water-laid deposits, which contain sufficient shale and clay-forming materials to produce a more coherent surface soil and a distinctly heavy subsoil. It is developed from nearly the same kind of materials as the Tracy soils. This soil occupies flat to gently undulating positions on the southern extremity of the outwash plain extending southward and southeastward from Haskells to the former Kankakee marsh. A total of 6,656 acres of this soil is mapped.

The plow soil of cultivated fields is light-brown or grayish-brown coherent fine sandy loam, which gradually becomes heavier textured below a depth of 10 inches. The subsoil is brownish-yellow granular clay loam that is sufficiently heavy and compact to retain considerable moisture. Below a depth of 2 feet rusty brown and gray mottling is developed in most places, and below a depth of 4 feet sand increases in quantity, forming definitely stratified layers separated here and there by seams of clay.

The dominant crops of the region are grown on this soil, and a higher level of production is attained than on the loose sandy soils, because of the more favorable range in moisture. Farmers usually attempt to follow a systematic rotation, but it is occasionally disrupted by crop failure. The crops grown in rotation are corn, oats or soybeans, wheat or rye, and clover or timothy. Corn yields about 25 to 30 bushels an acre. In order to build up the fertility level, farmers recognize the need for the growth of legumes in a systematic crop rotation. Many farmers make applications of 2 to 4 tons of lime an acre in order to grow alfalfa. It is also a common practice to use 100 pounds of hydrated lime to the acre in place of fertilizer in the drill rows when seeding soybeans. Most of the farm crops are fed to small herds of dairy or beef cattle.

Hanna loam.—Hanna loam is associated with the more extensive Hanna fine sandy loam and is developed from the same kind of parent material. Although the organic-matter content is low, it is more easily maintained than on the loose sandy soils.

The grayish-brown plow soil is underlain by a moderately compact yellowish-brown clay loam subsoil. In other respects the soil is similar to Hanna fine sandy loam. The supply of moisture is adequate to mature most crops; consequently slightly higher yields may be expected than on the fine sandy loam.

Alida fine sandy loam.—A few fairly large areas of Alida fine sandy loam are in the vicinity of Wanatah. This soil differs from Hanna fine sandy loam primarily in the browner color and slightly higher organic matter content of the soil. It is similar in toxic acidity and color to the Newton soils with which it generally is associated. The subsoil is more granular and more highly oxidized and drainage conditions are better than in Newton fine sandy loam. Crop adaptations and yields are similar to those of Tracy fine sandy loam.

Alida loam.—Most areas of Alida loam are in the vicinity of Wanatah, where they are associated with the Newton soils, forming the area known as Hauk Prairie. The soil covers a small total area.

In texture, clay content, and physical condition, this soil is similar to Hanna loam, but in color of surface soil and intensity of acidity it is similar to Alida fine sandy loam. Soil acidity is the most serious problem in the utilization of this soil. In order to grow legumes, especially alfalfa, farmers usually apply from 3 to 6 tons of ground limestone to the acre. Farming practices and crop yields are similar to those on Alida fine sandy loam.

Vaughnsville loam.—With the exception of a small area southeast of Kingsbury, Vaughnsville loam occurs entirely along the border of the moraine and the Lake Michigan Basin, extending from an area east of Otis to Posey Chapel. All the bodies are small, totaling only 192 acres. The largest tracts lie east of Waterford. The soil is developed from stratified sand, gravel, and marl deposits in low, frequently rather wet areas bordering marshy ground.

In cultivated fields this soil is conspicuous as reddish-brown irregular low ridges or swells surrounded by dark-colored soils. It ranges in texture from coherent loam to fine sandy loam. The subsoil is brownish-red slightly heavier loam, which becomes mottled with gray and yellow at an average depth of 20 inches. The soil generally is only slightly acid and in many places is underlain by marl-bearing silts and sands. As it occurs in small areas, its use is determined by the cultural practices on adjoining soil types, but it is reported to be well suited to pasture, corn, and truck crops, especially where it is artificially drained.

Nappanee silt loam.—Nappanee silt loam occurs on two undulating ridges, from ½ to 3 miles wide, paralleling Lake Michigan, where this soil is intricately associated with Brookston silty clay. These soils are developed from bluish-gray blocky impervious till of the Wisconsin glacial period. The limy mixture of clay and glacial material contains considerable shale.

The plow soil to a depth of 6 to 8 inches is gray or light-gray smooth silt loam that has a very low organic-matter content. With injudicious handling it puddles and bakes, producing hard clods that are very difficult to pulverize. Tillage operations can be carried on readily only within a rather narrow range of moisture. On the gently rolling areas the surface soil is grayish brown, but owing to the impervious substrata, the underlying subsoil never becomes free of mottling. Typically the subsoil, which reaches a depth of 15 inches, is mottled bluish-gray and yellow heavy silty clay loam. When dry this material is rather silty and when wet it is tough and plastic. The lower part of the subsoil, extending to the limy parent

material, which lies at an average depth of 2 feet, consists of bluish-gray very tough waxy silty clay. When moist it can be broken into angular blocks three-fourths of an inch in diameter. Moisture moves very slowly in this soil, and shallow-rooted crops are injured in dry weather.

Although all the principal farm crops are grown, this soil is best adapted to clover, timothy, and pasture. About 33 percent of the land is used in this way. As the soil is moderately acid, liming is necessary to grow alfalfa. Corn is grown on about 20 percent of the land, but the yield is usually low, owing to the inadequate supply of moisture. Only thin stands of corn and soybeans frequently are obtained because seedlings cannot break through the ground, which bakes badly on drying. Dairying and livestock raising are the most important agricultural enterprises.

Nappanee loam.—The largest areas of this soil are in the vicinity of Stitesville School, but small bodies are in the vicinity of Waterford associated with areas of Nappanee silt loam. Nappanee loam also is associated with the Allendale soils, which are developed from deposits of wind-blown sand, ranging from several inches to 3 feet or more in thickness, on heavy calcareous clay similar to the parent material of the Nappanee soils.

The 10-inch surface soil consists of gray or brownish-gray loam. As the sand was not deposited uniformly, soil boundaries are arbitrarily drawn between this and the Allendale soils in some places; therefore very small areas of loose sand may be included with the Nappanee soil. The subsoil to a depth of 18 inches is moderately friable, owing to a mixture of sand and clay, below which the blue-gray clay becomes very tough, compact, and impervious. This soil is only slightly acid throughout, and at an average depth of 31 inches the heavy till contains an abundance of free lime.

Owing to its excellent physical condition, this soil is considerably more productive than Nappanee silt loam. Corn and other grain crops occupy a larger proportion of the acreage of this soil than of the silt loam, although grasses and legumes also are well adapted. Yields of corn and oats average about 35 bushels an acre. Wheat is less seriously affected by the excess moisture conditions that prevail on Nappanee silt loam; consequently yields are higher, averaging about 18 bushels an acre.

Allendale loamy fine sand.—Because of the erratic deposition of sand on heavy clay, Allendale loamy fine sand varies widely from place to place. The color, texture, drainage, and physical condition may be distinctly different within a few feet because the sand cover ranges from a thin veneer to a thickness of 3 feet or more. The topography ranges from that of local flats to undulating low dunes. The small total area of this soil is mapped in a body extending northeastward from Waterford.

The surface soil to a depth of 12 inches consists of brownish-yellow loose loamy fine sand. Where the clay occurs at slight depths, drainage conditions are poor and the color approaches light gray. The surface soil under such conditions is slightly more coherent. Typically the subsoil consists of pale-yellow or grayish-yellow loamy fine sand, which becomes mottled and rusty-iron stained a few inches above the

clay substratum. Under very poor drainage and a shallow deposition of sand, the subsoil immediately below plow depth is mottled and stained. The thickness of the loose sand layer over the clay averages 30 inches; in few places does it exceed 4 feet. The bluish-gray clay contains some gravel and glacial pebbles, and in most places it is calcareous within 3 feet of the surface.

This soil normally contains an adequate supply of moisture to mature crops, although in local areas where the sand layer is thicker, crops may be injured by drought. Even though the surface soil is medium acid, legumes, especially alfalfa and sweetclover, are easily grown because of the abundance of lime in the subsoil. Light applications of lime are usually necessary, however, to start these crops. Allendale loamy fine sand and Nappanee loam are well adapted to all crops commonly grown in the county. Corn usually yields from 40 to 50 bushels an acre and wheat 10 to 20 bushels. Although bluegrass is not well adapted, meadows furnish adequate roughage and pasture for the dairy and livestock system of farming that is followed on this soil.

Otis silt loam.—Small flat areas of Otis silt loam occur on the rolling uplands where they are associated with areas of the Galena soil. The largest ones are south of Otis and north of Hudson Lake.

This soil is similar to Nappanee silt loam in many respects, although it does not have such a heavy and intractable subsoil. For this reason drainage can be improved on the Otis soils by tiling. The plow soil is light gray when dry and slightly brown when moist. A few areas, principally those south of Otis, have slightly dark gray plow soils. The organic-matter content of these darker areas is a little above average for the soil as a whole. The mottled subsoil is more friable than the corresponding layer of the Nappanee soils, owing to a higher proportion of sand. The soil mass is slightly more acid, and free lime occurs at a greater depth than in those soils. The limy parent material, consisting of a yellowish-gray heterogeneous mixture of sand, silt, and clay, ranges in depth from 3 to 6 feet but averages about 4 feet.

The use of this soil is determined largely by farming practices on the associated Galena soils. Owing to the impaired drainage conditions and low organic-matter content, farmers try to manure this soil a little more heavily than is customary and follow other practices designed to improve its productivity. Because of the more favorable physical condition, higher acre yields may be expected than on Nappanee loam.

Otis loam.—Although small bodies of Otis loam are scattered throughout the uplands, the larger ones are northwest and west of Westville. Only 640 acres of this soil are mapped. The soil is similar in most respects except texture to Otis silt loam. The surface soil and upper part of the subsoil contain sufficient sand to make the land friable and easily tilled. Free lime occurs at slightly greater average depths than in Otis silt loam. The agriculture practiced is similar to that on Otis silt loam.

Fulton fine sandy loam.—This soil occupies the flat land of two small lacustrine deposits, one at the head of Waterford Creek southwest of Waterford and the other at the head of Trail Creek in the vicinity of Springfield Township School. The total area is small.

The surface soil of the greater part of this soil is mellow fine sandy loam containing considerable clay binding material. A few areas have a heavier textured surface soil. West of Springville the surface soil in a small area is smooth silt loam, and the subsoil is silty clay loam. The typical subsoil between depths of 12 and 30 inches consists of mottled gray and yellow clay loam that is moderately plastic and sticky when wet. The underlying material consists of stratified sand and silt, which in places contains a small percentage of lime at a depth of 3 to 6 feet or more.

All the important farm crops are adapted to this soil. Crop adaptations and yields are similar to those of Nappanee loam and Allendale loamy fine sand.

Willvale loam.—Willvale loam occurs in fairly large areas on low terraces extending from the vicinity of Wanatah along the border of the outwash plain to the eastern side of the county and northward to the vicinity of Sauktown School.

The surface soil is brownish-gray coherent loam, which dries to light gray. It is very low in organic matter, having been developed under a timber cover consisting largely of black oaks and white oaks. The subsoil is mottled gray and yellow clay loam underlain by stratified sand, clay, and shaly gravel deposits. The texture, physical condition, and low position insure adequate supplies of moisture for the growth of crops. Drainage of this district is improved by open ditches in the nearby marshlands, thereby reducing the groundwater level in places. Yields of crops would be improved by additional drainage in some areas.

The crop adaptation and yields on this soil are similar to those of Hanna loam. The principal soil factors that reduce crop yields are excessive moisture at certain seasons of the year and the strong acidity. In the southeastern corner of the county east of Rivernook Church there is an area of the Willvale soils where legumes can be grown without the use of lime. Here, crop yields are considerably higher than elsewhere.

Willvale fine sandy loam.—This soil is widely distributed throughout the Kankakee Basin, but the largest bodies are in the vicinity of Wanatah. The total area mapped is not large. This soil is similar to Willvale loam in all respects except texture of the surface soil, which is mellow fine sandy loam. Because of the greater proportion of sand, this soil is slightly less productive than the heavier textured Willvale loam.

Willvale loamy fine sand.—This soil occurs in very small scattered bodies, aggregating a small total area, associated with areas of Tracy loamy sand. It is developed in small flats or slight depressions under very slow natural drainage. The 12-inch surface soil is brownish-gray or grayish-brown mellow loamy fine sand. It is underlain by a mottled gray and yellowish-brown or rust-stained sandy clay loam subsoil extending to a depth of 24 to 30 inches. The underlying material consists of yellow incoherent loose fine sand. The use of this soil is determined largely by the associated Tracy loamy sand.

Willvale loamy fine sand includes small areas totaling 1,920 acres, in the Lake Michigan Basin and in the Kankakee Valley south of United States Highway No. 30. Here it occupies low swells and

flat areas that border the marsh soils and are subject to periodic saturation. This soil consists of light-gray loose loamy fine sand, which is mottled immediately below plow depth. In other respects it is similar to Berrien loamy fine sand, with which it is associated. Market-garden crops and some small fruits, such as strawberries, are grown more widely than on the Berrien soil. In other respects the crops grown and yields are similar on the two soils.

DARK-COLORED WELL-DRAINED SOILS

The dark-colored well-drained soils contain more than average quantities of nitrogen and organic matter. The flat surface, high nitrogen content, and high organic-matter content of these soils have favored a cash-grain system of farming. Red clover and alfalfa are not well adapted, owing to the strongly acid reaction, and pasture and forage are scarce. Nevertheless dairying is assuming a more important place in the farming system south of La Porte because of accessible markets for fluid milk. This group includes members of the Door, Lydick, and Byron series.

Door loam.—This is the most extensive soil in the county, occupying 33,216 acres. It is the principal dark-colored Prairie soil of the outwash plain and occurs on irregular many-lobed areas extending from La Porte southwestward to Haskells, eastward to Wellsboro, and southeastward nearly to Union Center. A few detached small areas are near Boot Jack and elsewhere. The irregularity of the prairie boundary is due to stream dissection of the plain, improved drainage conditions, and subsequent encroachment of trees upon the prairie. The land is almost flat, although small kettle holes, less than 10 feet deep are common.

Door loam has a dark-brown loam surface soil, from 14 to 18 inches thick. The plow soil is more granular than the subsurface layer. Except in years of extremely low rainfall, crops do not suffer much from drought. The organic-matter content is high, although the amount present probably has been greatly depleted since this region was first brought under cultivation. Below the plow soil the angular structure particles are coated with a dusky-brown or black colloidal film. The dark color decreases and the proportion of fine earth increases with depth. Between depths of 18 and 30 inches the subsoil is brown or yellowish-brown clay loam that breaks into angular fragments from one-fourth to one-half inch in diameter. Below this the subsoil consists of friable loam or sandy clay loam, that is sticky when wet. Shale and gravel form an important part of the soil mass. At a depth ranging from 4 to 10 feet, the substrata consist of stratified deposits of shale, gravel, and sand. Rounded glacial boulders are common along the border of the uplands. At progressively greater distances from the morainic uplands, the source of these sediments during glacial times, the underlying layers become finer in texture.

This is an excellent agricultural soil as shown by the fact that about 95 percent of it is under cultivation and producing well. Corn, wheat, oats, and soybeans occupy about 70 percent of the cultivated acreage. A cash-grain system of farming is widely followed, and dairying is carried on extensively in the vicinity of La Porte. Pasture and meadows comprise about 10 percent of the crop acreage. As the soil

is strongly acid, leguminous hay crops, with the exception of soybeans, are not grown successfully without the use of lime.

Corn is the most important crop and occupies about 35 percent of the land. Although yields are reduced in years of drought, the average yield is about 40 bushels an acre. A very large proportion of this district was used for wheat when the land was first brought under cultivation. Wheat is now grown on about 20 percent of this soil. The yields always have been good, in some years ranging as high as 40 bushels an acre. They now probably average between 20 and 25 bushels an acre. Very little manure is produced, but the available supplies are used largely on the wheat. Commercial fertilizers are invariably used, the applications ranging from 125 to 200 pounds to the acre. From 60 to 100 pounds of fertilizer is usual for corn. Because of the acid condition of the soil, soybeans are the best adapted leguminous hay crop. Although they can be grown without the use of lime, soybeans return much higher yields—as much as 4 tons an acre—when lime has been applied. Since the value of lime is being recognized and it is being used more widely, the acreages of red clover and alfalfa are increasing. Rotations used include the following: (1) Corn, oats or soybeans, wheat, and clover; (2) corn, corn, sweetclover, oats or soybeans, and wheat; and (3) corn, oats, and wheat, followed by 1 year of fallow.

Door fine sandy loam.—Door fine sandy loam occurs on only a few small slightly elevated knolls on the prairie near Pinola and in Scipio Township.

The surface soil consists of moderately loose fine sandy loam or loamy fine sand in which clay and organic matter give the soil particles slight coherence. The dark color and organic-matter content are less pronounced and extend to slightly less depth than in the loam. The subsoil contains a little less clay than the corresponding layer in the loam; consequently moisture supplies are somewhat more limited for crop production. In a few places the proportion of clayey material is small, the subsoil is only slightly heavier textured than the surface soil, and loamy sand occurs at a depth of 20 inches. Because of the more open soil condition, rye, soybeans, and other crops best adapted to a limited supply of moisture, have a more important place in the farming system than they do on Door loam. Otherwise, adaptations, yields, and problems of management are similar on the two soils.

Lydick loam.—Lydick loam is transitional between the typical dark-colored Prairie soils (Door series) and the light-colored formerly timbered soils (Tracy series) of the outwash plain. This soil, occupies two types of locations. (1) The broader areas border the uplands east of Rolling Prairie and west of La Porte. These areas comprise a flat to undulating pitted plain. Kettle holes are numerous, and many of them are deep enough to be bordered by steep and, in many places, wooded slopes. (2) Narrow strips lie between the so-called black Prairie soils and the light-colored Tracy soils. Here the land is relatively flat, with few kettle holes. A large total area of this soil is mapped.

This soil, as indicated by its dark color, probably was developed under a grass cover. When the land was brought under cultivation it supported two types of timber cover. (1) Large areas closely asso-

ciated with the black prairie and surrounding kettle holes in the prairie had a pure stand of bur oak. Some of these trees remain along fence rows. The bur oak areas probably had comparatively little underbrush and considerable grass. (2) Areas that bordered those of the light-colored Tracy soils had a mixed forest cover consisting of sugar maple, American elm, and a variety of oaks.

The plow soil, in cultivated fields, to a depth ranging from 10 to 14 inches is brown loam having a fairly high silt content. The slightly higher organic-matter content, compared with that of Tracy loam, is more noticeable in fence rows where the dark color has not been lost through cultivation. The soil has a friable consistence and granular structure, which are favorable to tillage operations and the growth of plants. To a depth of 30 inches the subsoil consists of yellowish-brown clay loam that gradually becomes lighter textured with depth. Roots penetrate readily along the angular structure particles. The moisture-holding capacity, although good, is slightly less favorable than that of Door loam because of the lower organic-matter content. The mixed clay and sand below a depth of 30 inches grades into loose stratified silt, sand, gravel, and shale at a depth of 50 to 80 inches.

The agricultural productivity of this soil is well above the average for the light-colored soils of the county, but yields of some crops, particularly of corn, are reported to be 5 to 10 bushels lower than on Door loam. Systematic crop rotation that includes the growth of legumes is more generally followed than on the Door soil, in order to build up the supply of organic matter and to maintain yields of crops. A higher proportion of the crops are fed to livestock, particularly dairy cattle. All the major crops adapted to the county are grown on this soil.

Lydick fine sandy loam.—Lydick fine sandy loam is mapped in three principal districts: (1) South of Rolling Prairie, (2) south of Durham, and (3) along the stream northward from Clinton Township School. Smaller areas are scattered elsewhere along the edges of the prairie. The total area, however, is not large.

The 12-inch surface soil is brown or moderately dark-brown mellow fine sandy loam. Under cultivation, the supply of organic matter becomes depleted more rapidly than on the associated heavier textured soils. The subsoil is yellowish brown and in many places contains less silt and clay than normal, particularly where this soil is associated with Byron loamy fine sand. Because of the lower organic-matter content and lower clay content of the soil, moisture conditions are less favorable than those of Lydick loam for oats, corn, and grasses; consequently somewhat lower yields may be expected. Soybeans, rye, and alfalfa probably are more widely grown on this soil than on the heavier textured Lydick and Door soils. In a few areas, such as in those east of Summit, special crops, such as watermelons, cantaloups, and tomatoes. are grown and appear to be well adapted.

Byron loamy fine sand.—Byron loamy fine sand occurs mainly in two fairly large areas. The most important one extends southward from Rolling Prairie; the other lies between Durham and Door Village. The land is undulating to gently rolling. It has a dune-shaped configuration in places. The soil was developed from water-assorted sand and gravel, which probably was partly reworked by the wind.

The surface soil to a depth of 15 inches consists of moderately dark-brown loamy fine sand. The sand particles in some places have con-

siderable coherence, owing to a film of well-decomposed organic matter. On sloping areas around kettle holes or pits the accumulation of organic matter is less pronounced than elsewhere, extending to a depth of less than 1 foot. The soil becomes lighter colored with depth, and in many places it is weakly cemented with clay giving it a loam or clayey sand texture. When wet it is moderately sticky. Below a depth of 30 inches the subsoil consists of assorted stratified loose fine sand containing a few seams or strata of silty material. Gravel occurs in some places throughout the soil. At a depth of 2 to 3 feet the sand rests on heavier textured outwash material. The entire soil mass is strongly acid.

A mixed grain and livestock type of farming is followed, and all the major crops adapted to the county are grown. The supply of moisture is not so favorable to the growth of crops as in the heavier textured soils. The organic matter in the surface soil and the clay in the subsoil give the soil fair moisture-holding capacity, however. Corn yields an average of about 25 bushels an acre. A large part of this soil is under cultivation and a much smaller portion of it is idle or in summer fallow than of the light-colored sandy soils. Tree fruits, blackberries, raspberries, and special crops, such as watermelons, cantaloups, and tomatoes, appear to be well adapted to this soil, although they are grown only to a small extent.

DARK-COLORED POORLY DRAINED SOILS

Dark-colored poorly drained soils contain various quantities of well-decomposed organic matter that has been well mixed with the surface soil. They occur on the border of the old marsh where they were formerly subject to a fluctuating water table, so that they dried out occasionally. The surface soils are moderately dark gray, and the subsoils are mottled gray and yellow. These soils are members of the following series: Brookston, Washtenaw, Wallkill, Pinola, Wauseon, Toledo, Granby, Griffin, Newton, and Saugatuck. The Newton and Saugatuck soils are strongly acid.

Brookston silty clay.—Brookston silty clay is an upland soil that occupies very narrow shallow swales and depressions intricately mixed with the Nappanee soils. It occurs in small areas and only in the northwestern part of the county.

The 10-inch surface soil consists of moderately dark-gray tough impervious silty clay, which grades abruptly into mottled gray and yellow smooth tough clay or silty clay. This is underlain at an average depth of 42 inches by calcareous heavy clay containing a few glacial pebbles and sand grains. The surface soil is somewhat variable. In some of the deeper depressions it has a greater accumulation of organic matter than elsewhere. Where this soil borders Nappanee loam the surface soil is slightly more friable as a result of a slight mixture of sand. The higher organic content enables farmers to keep this soil in better physical condition than the associated Nappanee silt loam. Artificial drainage, although much needed, has not been very successful because of the heavy subsoil.

Agricultural practices are largely determined by the dominant Nappanee silt loam. Winter wheat may be drowned out, therefore it

is not adapted to this soil. Corn, soybeans, and grasses are well adapted. Good stands of red clover are usually obtained.

Brookston silty clay loam.—Brookston silty clay loam, an inextensive soil, is associated with the Galena, Otis, and Nappanee soils. It has a slightly darker deeper more friable surface soil than Brookston silty clay, and the subsoil is more pervious to the movement of moisture. It can be drained with tile where outlets are available. Crop adaptations are similar to the Brookston silty clay, but yields are slightly higher.

Washtenaw silt loam.[8]—This soil consists typically of light-colored colluvial deposits on top of darker older mineral soils. It occurs in kettle holes or pits ranging from a few feet to several hundred feet in width. It also occurs as a border around beds of muck that formerly were lakes. Internal drainage ranges from medium to very poor, depending somewhat on the depth of the kettle holes. These kettle holes are more common throughout the uplands, but they also occur on the outwash plain.

Typically, the surface soil consists of grayish-brown silt loam underlain by mottled gray and yellow silt loam. This rests on dark-gray silty clay loam within a depth of 4 feet. The surface soil is variable in texture, the coarser particles occurring around the borders of kettle holes and the fine sediments toward the center. The depth of the light-colored silty covering over the dark material ranges from a few inches to 6 feet or more.

It is the common practice to farm the shallow depressions that can be crossed with tillage implements. Probably one-fifth of this land can be cultivated. The soil is normally fairly productive as it consists of the surface soil washed from surrounding slopes. Water stands on these areas after rains, but it usually drains away within a few hours. Fall-seeded small grains frequently are drowned out, especially in the centers of the kettle holes. Spring-planted crops, such as corn, soybeans, and grasses, are best adapted to this soil.

Wallkill silt loam.—This is an inextensive soil of little agricultural value that occurs almost entirely in the deeper kettle holes of the uplands. It consists of light-colored silty colluvial deposits on organic soil. The colluvium ranges in thickness from a few inches to more than 3 feet. Drainage conditions are very poor, and much of the soil is timbered.

Pinola silt loam.—This soil consists of moderately dark-brown colluvial wash deposited in kettle holes on older dark-colored soils. This condition prevails throughout the prairie, which is a highly pitted plain in many places. The kettle holes generally are less than 5 feet deep, and many of them are fairly well drained. For these reasons a larger proportion of this soil is under cultivation. The same limitations on use prevail as with Washtenaw silt loam.

Wauseon loam.—Wauseon loam is a dark-colored soil of the depressions that occurs almost entirely in an area between Waterford and Hesston Corner, where it is closely associated with Allendale loamy

[8] Washtenaw and Wallkill silt loams are included with the dark-colored poorly drained soils, because their dark-colored subsoils were surface soils before being covered by light-colored material washed from the adjacent higher ground.

fine sand. It comprises a thin veneer of sand deposited on heavy calcareous ice-laid clay.

The moderately dark-gray surface soil is variable in texture, depending on the proportion of sand. The texture ranges from heavy loam to fine sandy loam, but the loam is dominant. The reaction of the soil is nearly neutral throughout, although areas having a higher proportion of sand may be medium acid. The subsoil consists of mottled gray and yellow or rusty iron-stained loam or fine sandy loam. It is underlain by heavy clay at a depth ranging from 1½ to 8 feet.

As Wauseon loam comprises a large proportion of the land where it occurs, its use is not limited by associated soils. The abundance of moisture, organic matter, and available plant nutrients, together with its favorable physical condition, combine to make it very productive for all the crops commonly grown. Yields of corn probably average 45 bushels an acre. In small areas that have not been tile drained and in which clay is close to the surface, wheat may be drowned out.

Toledo silty clay.—This is a dark-colored sweet soil of the depressions, developed from heavy calcareous slack-water or lacustrine deposits. Most of it occurs in two areas, the larger one on the Porter County line west of Winship School and the other northwest of Springville. The total area is very small.

The 14- to 18-inch surface soil consists of dark-gray silty clay loam, which, when properly managed, develops a granular mellow soil mulch. The abundant supply of organic matter causes the soil to pulverize easily. The subsoil consists of mottled gray and yellow or bluish-gray silty clay loam, which is underlain by limy silt and clay at a depth of 3 to 5 feet.

Adequate artificial drainage or tiling have been provided for this soil, which is well adapted to all the principal farm crops. Corn, wheat, and clover, the principal crops, return yields of about 50 bushels, 22 to 25 bushels, and 1½ to 2 tons of hay, respectively, an acre.

Granby loam.—This is a moderately dark soil of the depressions developed from water-assorted sands and silts containing a small quantity of free lime. Most of the bodies lie in former lakes at the head of Waterford Creek. A few bodies also occur near the Kankakee River between the Chesapeake & Ohio Railway and the Pennsylvania Railroad and southeast of Sauktown School on the county line. The total area is small.

The 12-inch surface soil is moderately dark-gray and ranges from heavy to light loam. It is underlain by yellowish-gray heavy loam, in which mottlings of rusty-iron stains are numerous. Stratified sands and silts occur at a depth of 4 feet or more below the surface. Some areas bordering the Kankakee River, which are included with this soil in mapping, have a little less organic matter in the surface soil and a higher proportion of fine-textured material. Much of this variation is used for pasture. Corn and wheat, the principal crops grown, are well adapted to this soil. Clover can be successfully grown in most places, although the surface soil is moderately acid in some places.

Granby fine sandy loam.—This soil differs principally from Granby loam in its greater content of sand throughout. The surface

soil consists of mellow fine sandy loam that is slightly browner in color than the loam and is lower in organic content than its surface soil. The subsoil is incoherent fine sand. Owing to the more porous condition of this soil, compared with Granby loam, acre yields, especially of corn, average slightly lower. Otherwise, crop adaptations are similar on the two soils. A total of 2,112 acres is mapped, mostly in the vicinity of Springfield Township School.

Griffin loam.—Areas of Griffin loam, an alluvial soil, are widely scattered along all the streams of the county, although the largest area is in the Kankakee River Valley above the entrance of Yellow River. This soil occupies the entire bottom-land area along small streams, but along the larger streams it occurs in places as a natural levee of slightly better drained land. The total area is not large.

Areas of this soil are variable in both color and texture, but in most places it is slightly dark brown, rust brown, or grayish brown. The organic-matter content is variable, depending on drainage and on soil texture. The texture ranges from silt loam to fine sandy loam, in some places within a short distance. Rusty-brown stains are conspicuous on the surface, and they become more pronounced with depth. The subsoil consists of mottled rusty-brown loam.

Owing to crop hazards from overflow, attempts to cultivate these soils have not been very successful. As the soil is nearly neutral in reaction and naturally rich in plant nutrients, it is suited to the growth of Kentucky bluegrass. Many of the larger areas are used for bluegrass pasture. About 40 percent of the land remains in timber.

Griffin silty clay loam.—The larger areas of Griffin silty clay loam are in the lower Kankakee Valley. This is not an extensive soil. It differs from Griffin loam mainly in the higher clay and silt content. The surface soil ranges from smooth silty clay loam to clay loam that contains considerable fine sand. In general, the heavier textured soil occupies the lower positions. In other respects Griffin loam and Griffin silty clay loam are similar in character and use.

Newton loamy fine sand.—Newton loamy fine sand occupies shallow depressions and nearly flat areas, where it has been subject intermittently to a fluctuating water table. The parent material consists of water-laid sand and a small quantity of fine-textured material. The original vegetation covering this soil throughout the greater part of its period of development was composed of sedges and grasses. During periods when drainage conditions improved, some trees also grew on it. White pine was common in the vicinity of Michigan City when the county was first settled. Because of the extreme acidity and general low level of fertility, many of the larger areas are idle, and the present vegetation consists largely of blackberry, dewberry, wintergreen, broomsedge, cinquefoil, and sheep sorrel (red sorrel). Artificial drainage is necessary in order to cultivate the land successfully. Much of it has been drained by open ditches.

Newton loamy fine sand is the most extensive member of the Newton series. It occurs throughout the Lake Michigan Basin and in minor scattered areas in the Kankakee Valley.

To a depth of 8 inches the plow soil consists of moderately dark brownish-gray loamy fine sand. The well-decomposed organic mate-

Aerial view of Hauk Prairie, looking northward from the Pinney-Purdue Experiment Farm on Newton fine sandy loam at Wanatah, La Porte County, Ind.: *a*, Gravel road; *b*, railroad; *c*, Pinney-Purdue experiment field; *d*, field of corn in shock; *e*, woodland; *f*, brushy fence line; *g*, barn; *h*, farmstead.

rial gives the soil a soft mellow consistence. The subsurface layer of brown loamy fine sand reaches to a depth of 14 inches. Most of the plant roots are in the upper foot of soil. The subsoil consists of mottled and rusty iron-stained, yellow, and gray fine sand, which is stratified at a lower depth. Although this soil is strongly acid in most places, many areas in the Lake Michigan Basin are less acid in the lower part of the subsoil below a depth of 3 feet.

The wild grasses and natural vegetative cover are used to a limited extent for pasture. Corn, soybeans, and small-grain crops, which can tolerate very strongly acid soils, are grown. The average yield of corn is about 20 bushels an acre. Yields of wheat usually range from 8 to 12 bushels. Investigations on Newton fine sandy loam at Wanatah indicate that the unproductiveness of these soils is due to high toxic acidity which may be corrected by heavy applications of lime. Seedings of red clover are unsuccessful, unless 2 tons or more of lime an acre is used. Market-garden crops and small fruits are grown to some extent in the vicinity of Michigan City.

Newton fine sandy loam.—This soil occurs only in the Kankakee Basin, the largest body being in the vicinity of Wanatah in the area known as Hauk Prairie (pl. 1). This soil has developed from water-laid sand deposits containing sufficient shale and clay-forming material to produce heavy subsoils. A fairly large total area is mapped.

The dark-colored surface soil is similar in color to that of Newton loamy fine sand, but the texture is fine sandy loam. The subsoil in many places is dominantly yellow to a depth of 20 inches, below which it is highly blotched and stained with rusty iron. The texture ranges from heavy loam to a clay loam. The lower part of the subsoil and the substratum consist of mottled gray and yellow loose fine sand.

Crop adaptations and yields are similar to those on Newton loamy fine sand. Commercial fertilizers are commonly used, especially on wheat. The heavier types of the Newton soils apparently require higher applications of lime as farmers report applications of 4 tons an acre. Large areas of this soil are used for pasture, although the native grasses are neither very palatable nor productive, as the growth is sparse and patchy.

Newton loam.—Large areas of Newton loam are around Wanatah and elsewhere throughout the Kankakee Valley. It differs mainly from Newton fine sandy loam in the loam texture of the surface soil. The subsoil consists of yellow or mottled gray and yellow heavy clay loam. Crop adaptations and use are similar to those for the other members of this series.

Saugatuck loamy fine sand.—Areas of Saugatuck loamy fine sand are on the Lake Michigan sand plain. No area occurs south of the Nappanee belt of soils. The topography is hummocky, and there are variations in color between the hummocks and the lower parts. The native vegetation consists largely of quaking aspen (popple or poplar), sassafras, cinquefoil, briers, and broomsedge. Only a small total area is mapped.

The surface soil ranges in color from moderately dark gray to brownish gray with varying quantities of rusty-iron stains. The rusty color is more pronounced on the slight elevations or hummocks. The surface soil ranges from loamy fine sand to fine sandy

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loam, the coherence being due largely to well-decomposed organic matter. Between depths of 9 and 12 inches is a layer of leached light-gray or gray fine sand, below which the soil is coffee-brown fine sand to an average depth of 24 inches. In most places the upper part of this layer is darker. The material is very firmly cemented where it occurs on the higher areas that have been above the ground-water level for a period of time. Cementation may be lacking in the lower positions, but it takes place on exposure to air. The underlying material consists of yellowish-brown loose fine sand that generally is unmottled. The areas include a soil similar to Newton loamy fine sand having a light-gray subsurface horizon. The entire soil mass is strongly acid.

Inherently, Saugatuck loamy fine sand is an inferior soil. Crops grown on the hummocky areas frequently have a spotted growth and poor appearance. On the lower areas, corn, wheat, oats, and soybeans appear to grow fairly well. Strawberries, blackberries, raspberries, and market-garden crops are grown to some extent. Many areas allowed to lie idle have been covered in a few years with aspen, sassafras, cinquefoil, and briers.

DARK-COLORED VERY POORLY DRAINED SOILS

The dark-colored very poorly drained soils occupy shallow marshes that before draining were permanently saturated. They include both mineral and organic soils.

The mineral soils are members of the Maumee series. They have dark surface soils underlain by a gray subsoil. They are rich in organic matter, abundantly supplied with plant nutrients, neutral to medium acid in reaction, and now, since they have been artificially drained, are generally productive. The supply of moisture is adequate to produce large crops. Only in exceptionally dry years are crops injured by drought. Crop adaptations and yields are similar on all members of the series. The principal crops are corn, oats, and wheat. These crops usually are sold as grain. The livestock kept on farms consist mainly of work animals, with a few dairy and beef cattle. Soybeans, mixed clovers, and timothy are grown to a limited extent mainly for feed. The usual crop rotation consists of corn, corn, oats, and wheat. Red clover is not very successfully grown without the use of lime, and when grown it suffers from heaving in winter. Uniform and moderately high yields of grain crops, together with soil conditions that are relatively unfavorable for pasture and meadow crops have combined to encourage a cash-grain system of farming.

Corn is grown on approximately 38 percent of these soils. Yields range from 40 to 60 bushels an acre and under good management average 50 bushels. Commercial fertilizers are used for both corn and wheat. Because of the high sand content, these soils are deficient in both phosphorus and potash; consequently the fertilizers used contain about equal proportions of phosphorus and potash. Nitrogen is not used, as adequate supplies exist in the soil. Oats and wheat are equally important, each occupying about 20 percent of the acreage. Yields of wheat average 25 bushels and of oats 40 bushels an acre. Owing to the gradual decline in fertility following several

decades of grain farming, more interest is being taken in the growth of clover and a system of farming that will maintain or increase crop yields. The use of lime is increasing on acid soils, especially where red clover and mixed hay form a part of the rotation. These are the most completely utilized soils in the county, less than 5 percent of them being classed as timberland or wasteland. Because the land is level and easy to till, tractors and power machinery are widely used.

At the time of settlement these soils were permanent marshes, generally known as the Kankakee marshlands. They remained in this condition until about the first of the present century when the widely meandering sluggish Kankakee River was dredged. Up to that time some marsh hay was cut from the higher areas. A very extensive system of dredged ditches has now reclaimed practically all this section for agricultural purposes, and the water of the Kankakee River flows in a channel from which all meanders have been eliminated.

The organic soils occupy 8.8 percent of the total area of the county. They have been developed by the filling of lakes of various depths with more or less decomposed plant material. The beds of muck and peat that comprise the organic soils vary widely in size and shape. They are most extensive in the Kankakee Basin, but some are in every township.

Because of wide variation in such characteristics as texture, structure, moisture condition, prevailing vegetation, degree of decomposition, color, and chemical character, the organic soils have been separated into four series of muck (Houghton, Carlisle, Edwards, and Kerston) in addition to peat.

MINERAL SOILS

Maumee loam.—Maumee loam is the most extensive member of this subgroup and the second most extensive soil in the county. The largest areas occur in the vicinity of La Crosse and in the extensive former marshes of the Kankakee Basin. Narrow strips also border the areas of muck of the outwash plain. As mapped, the greater part of Maumee loam in La Porte County is medium to strongly acid in the upper layers, and in this respect it differs from normal Maumee loam elsewhere. The soil needs applications of limestone in order to produce red clover, sweetclover, and alfalfa on drained areas.

The surface soil is dark-gray or moderately dark-gray loam from 12 to 24 inches thick. It contains a moderate proportion of clay, which causes the soil to be moderately plastic and sticky when wet. Owing to the abundance of organic matter and sand, the soil crumbles readily under cultivation into a mellow, fluffy condition. The content of organic matter decreases and the clay content increases with depth, the darker soil grading into a yellowish-gray clay loam subsoil that has considerable rust- and orange-colored iron stains. Although moisture moves freely through the artificially drained soil, the capacity to hold considerable moisture also is good. At a depth ranging from 2 to 3 feet the soil consists of stratified loose fine sand with some silt. A small quantity of free lime is present in most places at a depth of 3 to 5 feet below the surface.

Areas of typical Maumee loam that are neutral in reaction are of minor importance in this county. These sweet soils generally occur

in the vicinity of marl deposits, such as those under Edwards muck. Areas of this type, totaling about 600 acres, occur in the old glacial channel extending southwestward from Hesston Corner and scattered through the Kankakee Valley from an area northeast of Mill Creek. The soil is sweet enough to grow red clover and, in some places, alfalfa without the use of lime.

A total of about 2,100 acres of soil mapped as Maumee loam differs from the typical soil in the presence of rusty-brown blotches and the presence of bog iron ore concretions of variable size and shape in the surface soil and subsoil. In cultivated fields these areas are identified by dull reddish-brown or dark-brown spots of irregular shape and occurrence. In many places they occupy the slightly lower swales in the fields. Ordinarily, such areas are only slightly acid in reaction and are reported to grow clover better than the surrounding more acid soils. Otherwise, the crops grown and yields obtained are similar to those on the rest of Maumee loam.

Maumee fine sandy loam.—This soil is developed throughout the Kankakee Basin, especially in the vicinity of La Crosse and Rivernook Church. A fairly large total area is mapped. Like the greater part of Maumee loam in La Porte County this soil is more acid in the surface layers than is typical of Maumee soils elsewhere.

The surface soil consists of moderately dark-gray fine sandy loam that is more open and mellow than the surface soil of Maumee loam. Although clay loam is the ordinary texture of the subsoil, local variation in sand content is common, and a few areas have loam subsoils. The more sandy areas are likely to be slightly less productive than the typical areas. In other respects the crop adaptations and yields are similar to those of Maumee loam.

Maumee fine sandy loam, mucky phase.—This soil is intermediate in depth and content of organic matter between Houghton muck, shallow phase over sand, and Maumee fine sandy loam. The surface organic soil ranges from 6 to 12 inches in thickness, and it contains about 50 percent of organic matter. In other characteristics the soil is similar to Maumee fine sandy loam. With long-continued use it is likely that much of the organic material will be exhausted, and the soil will become more and more like typical Maumee fine sandy loam.

Maumee loamy fine sand.—The largest areas of Maumee loamy fine sand lie in the Kankakee Basin, but a few hundred acres occur in the northern part of the county. This is an extensive soil. It is formed from water-laid sand deposits that contain very small quantities of clay-forming minerals, so that the entire soil consists of slightly coherent fine sand. In the Lake Michigan Basin, Maumee loamy fine sand has an especially low content of clay in the subsoil. The surface soil consists of loose loamy fine sand in which the binding agent is largely organic matter. The subsoil and substrata consist of yellowish-gray iron-stained loamy fine sand. Since these distinctions are rather difficult to determine by surface observations, local areas of this soil in the Kankakee Basin may have inclusions that have slightly heavier textured subsoils. The greater part of Maumee loamy fine sand in La Porte County is medium to strongly acid in reaction in the upper layers, and in this respect the soil differs from typical Maumee loamy fine sand, which is either neutral or only slightly acid.

There are a few other variations in this soil. Some areas, as mapped in the abandoned glacial valley around Springfield Township School, are neutral to only slightly acid in reaction, whereas most of the soil is medium to strongly acid in the upper layers. Some clay-forming minerals present in the parent material in this valley may produce slightly heavier textured subsoils here and there. Another inextensive inclusion of only a few acres contains some rusty-iron discoloration. Areas formed in the Lake Michigan Basin are somewhat more acid than the average. They are less productive than the larger bodies.

Because of the higher sand content and the more limited supplies of plant nutrients, a lower level of productivity may be expected than in acid parts of Maumee loam. Otherwise, the cropping system and yields are similar to those of the heavier textured soil.

Maumee clay loam.—This inextensive soil occurs in depressions associated with Maumee loam mainly in the southwestern part of the county. The larger areas are near Bee Grove. Tillage operations are performed less easily on this soil than on Maumee loam, owing to the greater proportion of clay in the surface soil. Spots of this heavier textured soil are especially noticeable when plowing, because of the greater power requirement and the need for more careful management. This soil differs from typical Maumee loam of other areas in being medium to strongly acid in the upper layers.

Approximately 200 acres of a soil mapped in Springfield, Hanna, and Dewey Townships have a surface soil consisting of dark-gray clay loam, neutral in reaction, underlain by yellowish-gray clay loam. This soil is like typical Maumee clay loam as mapped in other counties. It is similar in crop adaptation to the rest of the soil included with Maumee clay loam, except that legumes can be grown without the use of lime.

ORGANIC SOILS

Houghton muck.—Houghton muck is the most extensive organic soil in the county—a total area of 18,688 acres being mapped. The larger areas are throughout the south-central and southeastern parts of the county. Most of this soil has been artifically drained so that it can be tilled. The depth to the water table ranges from about 2 to 3 feet in undrained areas. This is a well-decomposed muck, which has been derived largely from sedges and grasses, although small wood fragments are seen here and there and some wooded areas were reported at the time of resettlement. It is neutral to slightly acid in reaction and is well supplied with lime and phosphorus.

The surface soil is granular in structure and very dark brown or black in color. On drying, it shrinks greatly, becomes hard, and cracks into angular particles. Under cultivation, the dry plow soil forms a very fine organic mulch that is subject to considerable wind shifting in the more exposed locations. Between depths of 18 and 24 inches the soil becomes brown, but the material is well decomposed. Fibrous roots and other plant material become increasingly evident with depth. A small quantity of brown partly decayed wood appears in a few places at a depth of 3 feet, and fibrous material appears at a greater depth.

Because of its extent and the type of agriculture to which it is adapted, Houghton muck is one of the more important soils of the

county. Corn, bluegrass, and other general farm crops continue to occupy the greater proportion of the land, but a large acreage of special crops contributes an important share of the income derived from this soil.

In a land-use study of a sample area that was entirely under cultivation, it was learned that corn occupied 39 percent and bluegrass 31 percent of the area. This land is well suited to these crops. Yields of corn average about 40 bushels an acre, and yields as high as 70 bushels have been reported. The principal limitations in yields are the short growing season and the possibility of frost damage. Early maturing varieties of corn are grown because the crop cannot be safely planted before June 1. Corn may be killed by late frost in spring or early fall. Because of a deficiency of potash it is necessary to fertilize cornland with 100 to 150 pounds an acre of a fertilizer high in potash, such as 0-8-24 or 0-0-24. Small-grain crops, owing to larger available supplies of nitrogen in the soil, tend to produce excessive straw, resulting in lodging and loss of crop. Soybeans yield 22 to 25 bushels an acre.

The important special crops include potatoes, sweet corn, mint, onions, and carrots. Potatoes yield from 150 to 300 bushels an acre. They generally are fertilized with 250 to 500 pounds an acre of fertilizer analyzing 0-8-24.

The greater proportion of mint oil produced for the world is from mint grown on the well-decomposed muck soils of northern Indiana and southern Michigan. In 1939 La Porte County ranked eighth in the State in the production of this crop. Owing to crop hazards from freezing, wind erosion, and the mint beetle, the acreage in a 6-year period ranged from 2,000 to 4,000 acres, according to the county assessor's reports. Land devoted to mint usually is fertilized with 150 to 300 pounds an acre of 0-8-10 fertilizer. Fertilizer with a higher proportion of potash is used on the older muck. Yields of the oil range from 15 to 50 pounds an acre with a probable average of 25 pounds.

Houghton muck, where not overdrained, is well adapted to the culture of onions. Depth to the water table should be about 2 feet. The area planted to onions has ranged from 50 to 100 acres in the last 6 years, varying with market prices and freedom from difficulties, such as loss of the crop by wind erosion. The land usually is fertilized with about 500 pounds an acre of fertilizer analyzing 0-8-24. Yields of onions range from 250 to 900 bushels an acre, and 500 bushels an acre is considered a good crop.

Houghton muck, shallow phase over sand.—This variation from typical Houghton muck is developed in shallow lakes or around the borders of larger lakes. It consists of well-decomposed black muck resting on a sand substratum at a depth of less than 3 feet. The mineral content of the surface soil generally is higher than in the typical soil, as sand from the surrounding Maumee soils has been mixed with it. The total area is small.

Houghton muck, shallow phase over clay.—This soil is similar to Houghton muck, shallow phase over sand, except that the substratum consists of clay. It is even less extensive than that soil. Crop adaptations and yields are similar to those of the typical soil. Areas that have been burned deeply are likely to be very unproductive.

The practice of burning muck has been followed in the past to some extent, in order to remove weeds and crop residues and improve crop yields. Although it may produce immediate increases in yields, burning is a destructive practice, as it tends to raise the water table, to destroy the inherent productivity of the soil, and, in addition, to destroy the entire organic layer here and there where burning extends to the mineral substratum.

Carlisle muck.—Carlisle muck has developed under a dense timber cover consisting of elm, ash, soft maple, tamarack, quaking aspen, and willow. In soil character it is similar to Houghton muck. To a depth of 18 inches or more, the soil consists of black or dark-brown well-decomposed organic matter. Chips of woody material occur in increasing quantities from 6 inches downward, with brown logs and other plant residues in various stages of decomposition below a depth of 3 feet. Drainage conditions may be slightly better and decomposition may be advanced to a further state than in Houghton muck. Crop adaptations are similar on the two soils.

Edwards muck.—This soil is similar to Carlisle muck in color, degree of decomposition, and vegetative cover under which it has formed, except that it is underlain by a substratum of light-gray soft silty calcareous marl at a depth ranging from 1 to 3 feet and averaging about 18 inches. This material contains shells in many places. Although the reaction ranges from alkaline to medium acid, in most places it is only slightly acid. Areas that are neutral may be unsatisfactory for the growing of potatoes, because of the potato scab disease. The soil also tends to be more deficient in potash than Carlisle muck. Otherwise the crop adaptations are similar to those of other mucks.

Bodies of this soil occur principally in the Kankakee Valley and in the old glacial channel extending southwest from Hesston Corner. They cover a small total area.

Kerston muck.—This soil occurs around the heads of and along small streams throughout the uplands and the outwash plain. Natural drainage is very poor, owing to the slight gradient of the streams. The organic content is as much as 50 percent or more.

Kerston muck represents a condition in the small valleys where an almost pure organic soil is developed in one place, and a short distance away in a small unmappable area the soil is almost entirely mineral soil similar to Griffin loam. The dominant condition is a mixture of dark organic matter with pockets and layers of mineral matter consisting largely of sand. The subsoil is frequently saturated with water at a depth of 1 foot. As bluegrass grows luxuriantly on the cleared areas, the land is used largely for pasture. Probably 25 percent of it, however, remains timbered.

Peat.—Peat occurs mainly in small land-locked ponds in the upland and on the outwash plain bordering the upland. The aggregate area mapped is small. Most areas of peat have a vegetative cover consisting of a border of buttonbush surrounding a moderately thick growth of huckleberry, cinquefoil, ferns, moss, cotton grass, and briers. A few tamaracks may be present.

The 3-inch surface layer consists of a slightly dark-brown fibrous spongy mass of roots. It is underlain to a depth of 1 foot by yellow

or light-brown slightly decomposed fibrous peat, below which are well-preserved remains of leaves, roots, and stems. The water table is usually less than a foot below the surface. The entire mass is very strongly acid. This soil has little potential agricultural value because of drainage conditions, high acidity, and the raw undecomposed state of the vegetative matter.

MISCELLANEOUS LAND TYPES

Marl beds.—About 128 acres of land mapped as marl beds consists of light-gray soft marl deposits lying at or very near the surface of the ground. In a few places a dark-gray neutral to alkaline soil covering about 6 inches thick has developed. Small shells are present in most places in the marl. The neutralizing value of the marl varies widely, but it generally contains 80 to 95 percent of calcium carbonate, which makes it valuable as agricultural lime for correcting soil acidity. Marl beds occur south of Fish Lake and southeast of Hesston Corner. They are not suitable for farming.

Coastal beach.—Coastal beach comprises a strip of light-gray sand bordering Lake Michigan. It is subject to constant wash from the waves and usually is saturated with water. It has neither vegetative cover nor agricultural value. Only 128 acres are mapped.

Pits and dumps.—A few small areas of land in La Porte County consist of pits, from which sand or gravel have been taken for industrial use or for road material, and dumps where rubbish, junk, and soil material from the city have been dumped on low wet land. These areas have no agricultural value.

PRODUCTIVITY RATINGS

Table 10 lists the soils of La Porte County in the approximate order of their estimated general productivity under the prevailing practices of better soil management, with the most productive soils at the head of the table.

The rating compares the productivity of each of the soils for each crop to a standard, namely, 100. This standard index represents the approximate average acre yield obtained without the use of amendments on the more extensive and better soil types of the sections of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as is the soil with the standard index. The standard yield for each crop shown in table 10 is given at the head of each respective column. It is to be noted that no standards are given for other vegetables and pasture. This means that the ratings for other vegetables and pasture are only comparative within the county. The standards used here for mint, apples, peaches, and grapes have been selected only as standards for this part of Indiana, and it is not expected that they apply equally well in all parts of the United States. For example, a standard of 200 bushels an acre has been used for apples in some other areas. Soils given amendments, such as lime and commercial fertilizers, or special practices, such as irrigation, and unusually productive soils of small extent may have productivity indexes of more than 100 for some crops.

The indexes in table 10 are estimates of yields that are based primarily on interviews with farmers, members of the Purdue University Agricultural Experiment Station staff, the College of Agriculture staff, and others who have had experience in the agriculture of the county and State. As such, they are presented only as estimates of the average production over a period of years. It is realized that these estimates may not apply directly to specific tracts of land for any particular year, as the soils shown on the map vary somewhat from place to place, management practices differ slightly from farm to farm, and climatic conditions fluctuate from year to year.

The indexes in column A under each crop heading are estimates of the yields to be expected without the use of commercial fertilizer or lime and with only the infrequent or occasional use of manure and legumes in the rotation. In other words, the yields are those estimated for a so-called low level of management. The indexes in column B are estimates of the yields that are obtained under the common better farming practices that include the use of fertilizer and manure, together with legumes in the rotation. Wheatland commonly receives from 100 to 200 pounds of 2–12–6 or similar fertilizer. From 3 to 6 tons of lime are commonly applied, depending on the specific requirements of the soils in question, for the establishment of legumes in the rotation. The fertilizer practices on the mucks differ in that heavier applications are made of commercial fertilizers that are relatively high in potash. For example, Houghton muck receives from 250 to 500 pounds of 0–8–24 for potatoes. Mint receives about the same quantity of 0–8–10 fertilizer. Cover crops and green manure are used to a greater extent on the more sandy soils than on the heavy soils. Soils devoted largely to fruits are fertilized more heavily with nitrogen than soils producing the common farm crops. In short, column B refers to the more careful and intensive practices that are rather common for the production of the cultivated crops of the county.

Two ratings have been given for a number of the soil types to indicate the productivity under conditions of adequate artificial drainage as well as under the natural conditions of poor drainage. In fact, a considerable proportion of the agricultural production of La Porte County is obtained from soils that have been artificially drained. Artificial drainage is provided through the use of both ditches and tile. Drainage is yet inadequate on some of the soil types, and on parts of others, although artificial means have been installed and the productivity of these areas is intermediate between that of the adequately drained and undrained areas of the same soil type. Under actual farming practices, therefore, a considerable range in drainage conditions may exist for a given soil, and the ratings do not attempt to indicate all these conditions. Drainage of certain soils may be obtained through drainage of adjacent lower lying soils. For example, the Allendale soils are benefited by the artificial drainage of the adjacent swales of Wauseon and Brookston soils. Instead of giving the indexes for the drained and undrained condition under the same soil heading, the drained and undrained conditions are treated in table 10 as distinct soil phases. Thus, such soils as Toledo silty clay, Wauseon loam, Maumee loam, and Brookston silty clay loam when drained are

TABLE 10.—*Estimated productivity ratings of the soils of La Porte Co*

Soils [1] (types, phases, and land types)	Crop productivity index [2]								
	Corn (100=50 bushels)		Wheat (100=25 bushels)		Oats (100=50 bushels)		Rye (100=25 bushels)		Soybe (100= bush
	A	B	A	B	A	B	A	B	A
Toledo silty clay (drained)	90	100	80	100	90	100	80	100	90
Maumee loam (drained)	70	100	60	100	60	90	60	100	80
Wauseon loam (drained)	60	90	50	100	50	80	50	100	60
Brookston silty clay loam (drained)	80	100	60	80	70	80	60	80	90
Maumee clay loam (drained)	70	100	60	90	60	70	60	90	80
Granby loam (drained)	70	100	70	100	70	80	70	100	90
Maumee fine sandy loam (drained)	70	90	60	100	60	80	60	100	80
Maumee loamy fine sand (drained)	60	90	60	90	60	80	60	90	80
Granby fine sandy loam (drained)	60	80	60	100	50	70	60	100	60
Door loam	60	90	70	100	60	70	70	100	90
Lydick loam	60	80	70	100	60	70	70	100	80
Maumee fine sandy loam mucky phase (drained)	50	100	30	40	40	60	30	40	80
Carlisle muck (drained)	40	100							40
Houghton muck (drained)	40	100							40
Houghton muck, shallow phase over clay (drained)	40	100							40
Houghton muck, shallow phase over sand (drained)	40	100							40
Griffin loam (protected and drained)	80	90	40	60	50		40	60	60
Griffin silty clay loam (protected and drained)	80	90	40	60	50		40	60	60
Galena silt loam	60	80	80	100	70	80	80	100	70
Galena loam	60	80	80	100	70	80	80	100	70
Hillsdale loam	50	80	60	90	50	70	60	90	60
Door fine sandy loam	50	70	50	70	50	60	50	70	70
Lydick fine sandy loam	50	60	50	70	50	60	50	70	60
Tracy loam	50	80	60	90	50	70	60	90	70
Hillsdale fine sandy loam	40	70	50	70	40	60	50	70	50
Fulton fine sandy loam (drained)	70	80	70	80	60	70	70	80	80
Edwards muck (drained)	30	80							90
Lucas fine sandy loam	50	70	40	70	40	60	50	80	40
Allendale loamy fine sand (drained)	50	80	50	60	40	70	60	70	50
Vaughnsville loam (drained)	40	60	50	70	40	60	50	70	50
Brookston silty clay (drained)	70	80	60	80	20	50	60	80	60
Tracy fine sandy loam	30	70	50	70	40	60	50	80	60
Otis loam (drained)	50	70	70	80	50	80	70	80	80
Otis silt loam (drained)	50	60	70	80	40	70	70	80	80
Nappanee loam (drained)	60	70	60	80	50	70	60	80	70
Hanna loam (drained)	50	80	50	80	60	70	50	80	50
Hanna fine sandy loam (drained)	50	70	50	70	50	60	50	80	50

Soils [1] (types, phases, and land types)	Crop productivity index for—											
	Mint (100=40 pounds) [2]		Potatoes (100=200 bushels)		Onions (100=500 bushels)		Other vegetables [4]		Apples (100=300 bushels) [3]		Peaches (100=500 bushels)	
	A	B	A	B	A	B	A	B	A	B	A	B
Toledo silty clay (drained)												
Maumee loam (drained)			70	100			60	70				
Wauseon loam (drained)												
Brookston silty clay loam (drained)												
Maumee clay loam (drained)							60	70				
Granby loam (drained)							60	90				
Maumee fine sandy loam (drained)			70	100			50	70				
Maumee loamy fine sand (drained)												
Granby fine sandy loam (drained)							60	90				
Door loam												
Lydick loam												
Maumee fine sandy loam, mucky phase (drained)	50	100	60	100			50	70				
Carlisle muck (drained)	50	100	60	100	50	90	50	70				
Houghton muck (drained)	50	100	60	100	50	90	50	70				
Houghton muck, shallow phase over clay (drained)	50	100			50	90	50	70				
Houghton muck, shallow phase over sand (drained)	50	100	60	100	50	90	50	70				
Griffin loam (protected and drained)												
Griffin silty clay loam (protected and drained)												
Galena silt loam							40	50	80	90		
Galena loam							40	50	80	90		
Hillsdale loam							50	70	90	100	60	
Door fine sandy loam												
Lydick fine sandy loam												
Tracy loam												
Hillsdale fine sandy loam							50	70	70	90	60	
Fulton fine sandy loam (drained)												
Edwards muck (drained)	50	80	50	90	40	80	50	70				
Lucas fine sandy loam												
Allendale loamy fine sand (drained)												
Vaughnsville loam (drained)			50	70			50	70				
Brookston silty clay (drained)												
Tracy fine sandy loam												
Otis loam (drained)												
Otis silt loam (drained)												
Nappanee loam (drained)												
Hanna loam (drained)												
Hanna fine sandy loam (drained)												

See footnotes at end of table.

TABLE 10.—*Estimated productivity ratings of the soils of La Porte County,*

Soils (types, phases, and land types)	Crop productivity index								
	Corn (100=50 bushels)		Wheat (100=25 bushels)		Oats (100=50 bushels)		Rye (100=25 bushels)		Soyb (100 bush
	A	B	A	B	A	B	A	B	A
Byron loamy fine sand	30	70	30	50	40	50	40	60	30
Willvale loam (drained)	40	70	40	80	50	70	40	80	40
Alida loam (drained)	40	70	60	80	40	60	60	80	60
Willvale fine sandy loam (drained)	40	60	40	80	40	60	40	80	40
Tracy loamy fine sand	30	70	40	60	30	40	50	70	40
Pinola silt loam (drained)	50	60	40	50	50	60	40	60	40
Alida fine sandy loam (drained)	30	60		50		40		60	
Coloma loamy fine sand [1]	10	50	10	40		20	10	50	20
Tracy loamy sand	20	50	30	60	10	30	40	70	30
Berrien loamy fine sand (drained)	30	50	40	60	30	40	40	60	
Tracy loam, slope phase	20	40	20	40	20	40	30	50	20
Newton loamy fine sand (drained)	40	60	20	40	50	60	30	60	30
Nappanee silt loam (drained)	40	50	40	60	60		40	60	50
Newton loam (drained)	30	60	10	30	40	60	10	50	20
Newton fine sandy loam (drained)	30	60	10	30	40	60	10	50	20
Washtenaw silt loam (drained)	50	60	40	50	50	50	40	50	50
Plainfield fine sand	20	60	30	60	10	30	40	70	30
Willvale loamy fine sand (drained)	30	50	30	50	20	40	30	50	30
Otis loam (undrained)	30		60				60		50
Otis silt loam (undrained)	30		60				60		50
Brookston silty clay loam (undrained)	50		20		30		20		50
Granby loam (undrained)	50		30		40		30		40
Saugatuck loamy fine sand (drained)	30	50	20	30	30	40	30	40	30
Fulton fine sandy loam (undrained)	40		50		20		50		60
Allendale loamy fine sand (undrained)	40		40		30		50		40
Brookston silty clay (undrained)	50								40
Tracy loamy sand, slope phase	10	40	30	40	10	30	30	50	30
Tracy loam, eroded phase	10	40	30	50	10	20	30	50	30
Nappanee loam (undrained)	50		40				40		40
Tracy fine sandy loam, slope phase	20	30	20	30	20	30	20	40	20
Plainfield fine sand, rolling phase	10	40	30	40	30	50	20	40	
Alida loam (undrained)	30		50		30		50		50
Hanna loam (undrained)	30		30		40		30		40
Hanna fine sandy loam (undrained)	30		30		30		40		40
Pinola silt loam (undrained)	40		30		20		30		30
Willvale loam (undrained)	30		20		30		20		20
Willvale fine sandy loam (undrained)	30		20		30		20		20

Soils (types, phases, and land types)	Crop productivity index for—											
	Mint (100=40 pounds)		Potatoes (100=200 bushels)		Onions (100=500 bushels)		Other vegetables		Apples (100=300 bushels)		Peaches (100=50 bushels	
	A	B	A	B	A	B	A	B	A	B	A	B
Byron loamy fine sand							50	70				
Willvale loam (drained)												
Alida loam (drained)												
Willvale fine sandy loam (drained)												
Tracy loamy fine sand												
Pinola silt loam (drained)												
Alida fine sandy loam (drained)												
Coloma loamy fine sand [7]											40	
Tracy loamy sand												
Berrien loamy fine sand (drained)												
Tracy loam, slope phase												
Newton loamy fine sand (drained)							50	70				
Nappanee silt loam (drained)												
Newton loam (drained)												
Newton fine sandy loam (drained)												
Washtenaw silt loam (drained)												
Plainfield fine sand												
Willvale loamy fine sand (drained)												
Otis loam (undrained)												
Otis silt loam (undrained)												
Brookston silty clay loam (undrained)												
Granby loam (undrained)							50					
Saugatuck loamy fine sand (drained)							50	70				
Fulton fine sandy loam (undrained)												
Allendale loamy fine sand (undrained)												
Brookston silty clay (undrained)												
Tracy loamy sand, slope phase												
Tracy loam, eroded phase												
Nappanee loam (undrained)												
Tracy fine sandy loam, slope phase												
Plainfield fine sand, rolling phase												
Alida loam (undrained)												
Hanna loam (undrained)												
Hanna fine sandy loam (undrained)												
Pinola silt loam (undrained)												
Willvale loam (undrained)												
Willvale fine sandy loam (undrained)												

See footnotes at end of table.

TABLE 10.—*Estimated productivity ratings of the soils of La Porte County,*

Soils (types, phases, and land types)	Crop productivity index								
	Corn (100=50 bushels)		Wheat (100=25 bushels)		Oats (100=50 bushels)		Rye (100=25 bushels)		Soyb (100= bush
	A	B	A	B	A	B	A	B	A
Alida fine sandy loam (undrained)	20		30		20		40		40
Granby fine sandy loam (undrained)	40				30				
Toledo silty clay (undrained)	30								40
Wauseon loam (undrained)	20				30				30
Kerston muck (protected and drained)	40	60	20	30	30		20	30	50
Berrien loamy fine sand (undrained)	20		30		20		30		30
Hillsdale loam, eroded phase	10	30	10	30			10	30	
Galena silt loam, eroded phase	10	30	10	30			10	30	
Nappanee silt loam (undrained)	20		30		40		30		40
Edwards muck (undrained)									40
Vaughnsville loam (undrained)	20								30
Carlisle muck (undrained)									
Houghton muck (undrained)									
Houghton muck, shallow phase over clay (undrained)									
Houghton muck, shallow phase over sand (undrained)									
Wilvale loamy fine sand (undrained)	20		20		10		20		20
Washtenaw silt loam (undrained)	20								30
Newton loamy fine sand (undrained)	20				30				
Newton loam (undrained)	20				30				
Newton fine sandy loam (undrained)	20				30				
Hillsdale loam, slope phase	10	30							
Hillsdale fine sandy loam, slope phase	10	30							
Maumee fine sandy loam, mucky phase (undrained)									40
Saugatuck loamy fine sand (undrained)	20				10				
Peat [1] (drained)	10	40							
Wallkill silt loam [1] (drained)									
Griffin loam (unprotected and undrained)	20								
Griffin silty clay (unprotected and undrained)	20								
Hillsdale loam, gullied phase		20							
Galena loam, slope phase									
Galena silt loam, steep phase									
Wallkill silt loam (undrained)									
Maumee loam (undrained)									
Kerston muck (unprotected and undrained)									
Peat (undrained)									
Galena silt loam, gullied phase									
Bridgman fine sand									
Plainfield fine sand, blow-out phase									
Coloma loamy fine sand, blow-out phase									
Coastal beach									
Marl beds									

Soils (types, phases, and land types)	Crop productivity index for—											
	Mint (100=40 pounds)		Potatoes (100=200 bushels)		Onions (100=500 bushels)		Other vegetables		Apples (100=300 bushels)		Peache (100=50 bushels	
	A	B	A	B	A	B	A	B	A	B	A	B
Alida fine sandy loam (undrained)												
Granby fine sandy loam (undrained)							50					
Toledo silty clay (undrained)												
Wauseon loam (undrained)												
Kerston muck (protected and drained)												
Berrien loamy fine sand (undrained)												
Hillsdale loam, eroded phase												
Galena silt loam, eroded phase												
Nappanee silt loam (undrained)												
Edwards muck (undrained)	30		40		40		40					
Vaughnsville loam (undrained)			30									
Carlisle muck (undrained)	30		50		40		40					
Houghton muck (undrained)	30		50		40		40					
Houghton muck, shallow phase over clay (undrained)	30		60	100	40		40					
Houghton muck, shallow phase over sand (undrained)	30		40		40		40					
Willvale loamy fine sand (undrained)												
Washtenaw silt loam (undrained)												
Newton loamy fine sand (undrained)							30					
Newton loam (undrained)												
Newton fine sandy loam (undrained)												
Hillsdale loam, slope phase												
Hillsdale fine sandy loam, slope phase												
Maumee fine sandy loam, mucky phase (undrained)							30					
Saugatuck loamy fine sand (undrained)							30					
Peat [8] (drained)												
Wallkill silt loam [8] (drained)												
Griffin loam (unprotected and undrained)												
Griffin silty clay (unprotected and undrained)							60					
Hillsdale loam, gullied phase												
Galena loam, slope phase												
Galena silt loam, steep phase												
Wallkill silt loam (undrained)												
Maumee loam (undrained)							50					
Kerston muck (unprotected and undrained)												
Peat (undrained)												
Galena silt loam, gullied phase												
Bridgman fine sand												
Plainfield fine sand, blow-out phase												
Coloma loamy fine sand, blow-out phase												
Coastal beach												
Marl beds												

See footnotes on next page

[1] The soils are listed in the estimated approximate order of their general productivity under prevailing practices of good farm m drained and undrained conditions—are given to those soils that are commonly drained artificially. These ratings do not apply, th of drainage exist.

[2] The soils are given indexes that indicate the approximate average production of each crop in percent of the standard of refere obtained without the use of amendments on the more extensive and better soil types of those regions of the United States in whi dex indicates that the crop is not commonly grown. The indexes are based on estimates of yields, as specific yield data are very li each crop refer to yields obtained under a comparatively low level of management that does not include the use of commercial and manure; the indexes in the columns headed B refer to yields obtained under management that includes the use of manure, and green manures. Details of the practices under B vary, of course, with the requirements of individual crops and soils.

[3] The standards used here for these crops have been selected only on the basis of yields in Indiana. They are not considered

[4] These indexes are only locally comparative and do not refer to actual yields or to specific vegetables.

[5] These indexes are only locally comparative, although they probably approximate indexes based on 100=100 cow-acre-days, w alent of the number of animal units supported on 1 acre for the given number of days.

[6] This is a generalized statement and grouping of relative productivity.

[7] This soil is used to a considerable extent for small fruits, melons, and strawberries, for which no indexes are given.

[8] These soils are essentially nonarable as artificial drainage is very difficult, if not impossible, to establish.

the most productive soils in the county for the common farm crops, but if undrained their productivity falls below that of other soils, some of which, though less fertile, are better drained. The ratings for the undrained condition of these soils are given farther down in the table. No attempt is made in the table to give the average condition of productivity and drainage of the soil type as it is currently used in the county. Reference to the individual soil type descriptions should be made for that information.

The principal factors affecting the productivity of land are climate, soil (this includes the many physical, chemical, and biological characteristics), slope, drainage, and management including the use of amendments. No one of these factors operates separately from the others, although some one may dominate. In fact, the factors listed may be grouped simply as the soil factor and the management factor, since slope, drainage, and most of the aspects of climate may be considered as characteristics of a given soil type, and because the soil type occupies specific geographical areas characterized by a given range of slope and climatic conditions. Crop yields over a long period of years furnish the best available summation of the associated factors and, therefore, are used when available.

The arrangement of the soils on the basis of their general productivity was made primarily on the indexes assigned to column B, and more weight was given to the indexes of the major crops than to those of the minor crops. No precise mathematical procedures were followed in setting up this order, since it is difficult to measure mathematically either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soils for particular crops. Too much significance, therefore, should not be given to the exact order in which the soils are listed although the arrangement does give information as to the comparative general productivity, as suggested by the statements in the right-hand column headed "General productivity."

Productivity tables do not present the relative roles that soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables show the relative productivity of individual soils. They cannot picture in a given county the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types devoted to each of the specified crops.

Economic considerations play no part in determining the crop productivity indexes. They cannot be interpreted, therefore, into land values except in a very general way. Distance to market, relative prices of farm products, and other factors influence the value of land. It is important to realize that productivity, as measured by yields, is not the only consideratiton that determines the relative worth of a soil for growing crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained, are examples of considerations other than productivity that influence the general desirability of a soil for agricultural use. In turn, steepness of slope, presence or absence of stone, the resistance to tillage offered by the soil because of its consistence or structure, and the size and shape of areas are characteristics that influence the relative ease with which soils can be tilled. Likewise, inherent fertility and suscepti-

bility to erosion are characteristics that influence the ease in maintaining soil productivity at a given level. Productivity, as measured by yields, is influenced to some degree by all these and other factors, such as moisture-holding capacity of the soil and its permeability to roots and water. Therefore, they are not factors to be considered entirely separate from productivity, but, on the other hand, schemes of land classification to designate the relative suitability of land for agricultural use must give some separate recognition to them.

MORPHOLOGY AND GENESIS OF SOILS

The character of the soil at any given place is the product of a great variety of factors, some of the more important of which are: (1) particle size and mineralogical composition of the parent material; (2) climate, particularly the temperature, and the amount and distribution of the rainfall; (3) relief, or lay of the land; (4) drainage, both external and internal; (5) character of vegetation, especially whether grass or timber; and (6) length of time that the soil has been developing.

Like all northern Indiana, La Porte County was entirely glaciated and the underlying sedimentary rocks were covered to a depth of 100 feet or more in most places by till or outwash deposits. The character of the glacial drift varies widely from place to place ranging from stones and gravel to sands, silt, and heavy clay. It is composed of fragments and the products of decomposition of many kinds of rocks, including sandstone, shale, granite, gneiss, schist, and limestone. Some of the sandy materials are composed almost entirely of quartz. Both the unassorted till and most of the assorted drift include a great deal of Devonian shale of local origin.

The climate is temperate and moderately humid. The mean temperature ranges from 25° F. in winter to 71° in summer. The temperature fluctuates above and below 32° during the winter, resulting in alternate freezing and thawing, although Lake Michigan moderates the temperature. (This effect is more significant in agriculture than it is in soil genesis.)

During the coldest months the ground is protected almost continuously by a blanket of snow. The annual snowfall averages 47 inches. The mean annual precipitation of over 37 inches is distributed almost uniformly throughout the year.

The soil climate varies more widely than the regional climate. Net moisture from precipitation is closely related to topography and infiltration capacity of the soils. Even though the range in relief is not great, runoff results in a much higher water supply in the marsh soils of the depressions and a lower supply on the sloping areas, a fact which contributes to the variations in the degree of leaching. Some soils develop under waterlogged conditions where they are not subject to freezing or thawing, whereas others are subjected to intermittent freezing and thawing as well as intermittent wetting and drying. Soil temperature is affected by the color and organic-matter content of the soils as well as by the character of the native vegetation, which also causes differences in evaporation on the timbered and prairie land.

Local relief and drainage conditions have greatly influenced soil development, not only by affecting the soil climate as indicated above, but with respect to the water level and the degree of leaching. A high water table and retarded drainage in level or depressed areas in many places promote the development of claypans or the accumulation of organic matter. Claypan formation is restricted largely to level or undulating land where the soils contain considerable quantities of clay-forming minerals in the parent material (*3*). The soil moisture conditions also control to considerable extent the distribution of the native vegetation. Where the soils have permeable substrata with good outlets they are droughty. About 52 percent of the area of soils were developed under poor drainage. Of this amount 9 percent represents organic soils, 31 percent mineral marshland soils, and only 12 percent imperfectly drained light-colored soils.

In about 68 percent of the county the soils have been developed under a mixed deciduous hardwood cover consisting largely of beech-maple, or black oak-white oak timber types. The beech-maple timber type grows largely on heavier soils (the Galena and Otis), where the supply of moisture is adequate, whereas almost pure stands of black oak grow on droughty soils, such as members of the Plainfield series. Bur oak encroaching on the prairie has resulted in the formation of soils (those of the Lydick series), which are transitional between the Prairie and the timbered soils. On the well-drained Prairie soils bluejoint turkeyfoot (big bluestem) and prairie beardgrass (little bluestem) were the principal native grasses, and grassy vegetation gave the soils their characteristic dark color. Sloughgrasses, rushes, reeds, sedges, and a few water-loving trees comprised the native vegetation of the marshes and swamps. The growth of pin oaks along the borders of the marshland generally had little effect on the soil character, which was determined by the grasses. Much of the organic soils that have been derived from sedges and grasses had a growth of tamarack and, in some places, birch, maple, and elm at the time the soils were brought under cultivation.

Since most of the surface deposits of La Porte County belong to the Late Wisconsin period, there is little difference in the geological time factor among the soils, except in the alluvial deposits, which are of very recent origin. The effect of time is expressed to some extent by the depth of leaching. Over the county as a whole, the depth to which carbonates of calcium and magnesium present in the parent material have been removed by leaching ranges from 3 to more than 6 feet. This is particularly true of the more mature well-drained eluviated ABC soils. The depth and the degree of leaching vary considerably, however, with the character of the parent material and drainage where the time factor is the same. Variation in depth corresponds to wide variation in the quantity of bases present and in the physical and mineralogical composition of the parent material.

Soils such as the Nappanee and Otis silt loams having heavy B horizons and strongly calcareous heavy C horizons are leached to a depth of about 3 feet; whereas the Tracy and Door soils having fairly heavy B horizons but permeable stratified gravel and sand C horizons, with low lime content, are leached to a depth of 6 feet or more. The Coloma and Plainfield soils having no accumulation of clay and being

developed from material high in quartz and low in lime are leached to a depth of 10 feet or more. The marsh and swamp soils occurring in depressions are only slightly to moderately leached.

According to the morphology and chemical features of the profiles, the zonal soils of La Porte County belong to the Gray-Brown Podzolic and Prairie great soil groups (*8*). The principal features are the leaching of the soluble materials from the solums and the accumulation of colloidal materials in the subsoils. The retention of coarser silica particles in the upper part and the mechanical downward movement by percolating water of finer textured material results in the formation of a lighter textured A horizon and the heavy-textured B horizon. The more thoroughly leached parts of the soils are acid in reaction. The lighter colored surface soils and rather strongly leached lower A and upper B horizons of the soils developed under timber gives them the characteristics of the Gray-Brown Podzolic soils, whereas the soils in about 20 percent of the area of La Porte County, developed under a tall-grass cover, have the darker colored surface soils and fairly dark subsurface soils characteristic of the Prairie soil region, which extends westward to the border of the Great Plains.

The following key to the soils of La Porte County (table 11) is a tabular arrangement of all the soil types according to catenas and major drainage characteristics.

A soil catena (*9*) is "a group of soils within one zonal region developed from similar parent material but differing in characteristics of the solum, owing to differences in relief or drainage" (*12, p. 1164*). The concept of soil "zone" as used in this definition means that the regional climate is the same and the native vegetation is similar. Each horizontal line on the key comprises a soil catena. For instance, the Lucas, Fulton, and Toledo soils comprise a catena developed from calcareous stratified lacustrine fine sand, silt, and clay, under deciduous forest.

The major drainage characteristics constitute the successive steps or gradations within the various catenas, and the soil type names are so arranged in the key that the soils similar in these respects are placed in the same vertical columns. In other words, all the soils named in any given column have approximately equivalent drainage conditions and resemble each other considerably for a given physiographic group in the lay of the land and the appearance of the surface horizon.

In addition to being arranged according to catenas and major profile characteristics the soil series are grouped physiographically within the key into upland, outwash plains, and bottom land groups. Under these physiographic groupings are subdivisions made on the character of the parent material.

This key arrangement also places the soils, according to features that are significant, from a soil climatic point of view, in three broad groups, namely, zonal, intrazonal, and azonal soils (*1*).

A more specific and detailed explanation of the key follows: Information in the vertical columns indicates the color of the surface soil, color of the subsoil, and topography. The three major groups of zonal, intrazonal, and azonal soils of the table are subdivided vertically on the basis of internal drainage into eight major groups in which the internal drainage characteristics become progressively poorer from left to right.

TABLE 11.—*Key to the soils of La Porte County, Ind.*

Soil characteristics	Zonal soils					In
	Prairie	Gray-Brown Podzolic		Half-Planosols	Planosols	
Color of surface soil	Dark brown	Medium to light brown.	Brown to grayish brown.	Grayish brown	Brownish gray	M
Color of subsoil	Brown	Reddish brown.	Yellowish brown.	Pale yellow, mottled below 18 inches.	Mottled below 10 inches.	M
Relief		Rolling to level	Moderately rolling.	Gently sloping to undulating.	Undulating to level.	D
Natural surface drainage	Rapid	Rapid	Medium to rapid.	Medium to slow.	Slow	V
Natural internal drainage	Very rapid	Very rapid	do	Slow	Very slow	
Upland soils:						
Late Wisconsin moraine:						
Heavy calcareous till					Nappanee silt loam.	E
Shallow sand deposits on heavy calcareous till.					Nappanee loam.	V
					Allendale loamy fine sand.	
Moderately heavy slightly calcareous till, high in shale.			Galena silt loam.		Otis silt loam	E
Similar with less shale and more sand.			Galena loam		Otis loam	
Light slightly calcareous till, high in quartz sand.			Hillsdale loam			
			Hillsdale fine sandy loam.			
Very sandy till		Coloma loamy fine sand.				
Outwash plains and old lake beds:						
Stratified fine sand, silt, and clay—calcareous lacustrine.			Lucas fine sandy loam.		Fulton fine sandy loam.	T

TABLE 11.—*Key to the soils of La Porte County, Ind.*—Contin

Soil characteristics	Zonal soils			In		
	Prairie	Gray-Brown Podzolic		Half-Planosols	Planosols	
Outwash plains and old lake beds—Continued						
	Door loam	Tracy loam		Alida loam [1]	Willvale loam	N
	Door fine sandy loam.	Tracy fine sandy loam.		Alida fine sandy loam	Willvale fine sandy loam.	
Slightly calcareous outwash gravel containing considerable shale.	Lydick loam [2]			Hanna loam		G
	Lydick fine sandy loam.[2]			Hanna fine sandy loam.		G
Timbered, light colored	Byron loamy fine sand	Tracy loamy fine sand		Hanna loamy fine sand.	Willvale loamy fine sand	
		Tracy loamy sand.				
Water-laid sand subsequently partly wind-assorted.		Plainfield fine sand.		Berrien loamy fine sand		N
					Vaughnsville loam.	S
					Coastal beach	
Overflow bottom land and kettle holes:						
Alluvial deposits					Griffin silty clay loam	
					Griffin loam	
Colluvial deposits				Washtenaw silt loam.		
				Wallkill silt loam.		
				Washtenaw silt loam, dark-colored phase.		

[1] Organic soils are associated with several soil groups or catenas. A supplementary key (table 12) presents the more importa
[2] Semidark in color, prairie-forest transition.

Major changes in character of drainage occur between soils listed under Planosols and those listed under Half-Bog soils and between the half-Planosols and Gray-Brown Podzolic soils. The Half-Bog and Bog soils have been developed under nearly permanent saturation, and the accumulation of organic material dominates the soil character. The half-Planosols and Planosols are imperfectly drained and have mottled subsoils, and there is a strong tendency toward development of a claypan where clay-forming parent materials are present. Inadequate drainage is one of the factors in formation of soils of the intrazonal group, which prevents them from fully expressing the factors of regional climate and vegetation.

Soils in the left-hand and middle columns under zonal soils are developed under conditions of very rapid internal drainage resulting from permeable substrata of sand or gravel. This is reflected in the well-oxidized mottle-free subsoils. The left-hand column includes dark-colored Prairie soils and the middle column the light-colored (Gray-Brown Podzolic) soils of timbered areas.

The soils in the right-hand column of zonal soils are well-drained but are developed from moderately heavy parent materials, and, with the other zonal soils give full expression to the regional, climatic, and vegetation factors.

The half-Planosols have yellow B horizons with imperfect drainage evident in mottled subsoils at a depth of 20 to 24 inches.

Planosols have been subject to alternate periods of oxidation and reduction as shown by the mottled gray and yellow B horizon and some mottling extending to the surface.

Half-Bog and Bog soils have developed for the most part either under water or under permanently moist conditions resulting in the accumulation of organic matter. The ground water in most of the region is alkaline. The Half-Bog are mineral soils varying in organic content and degree of saturation during development. Half-Bog soils of the first group have a fairly high accumulation of organic matter and mottled gray and yellow subsoils. Those of the second group are darker, higher in organic content than those of the first and have rust-stained bluish-gray subsoils. Soils listed under Half-Bog actually belong largely to the Half-Bog group, although areas of Wiesenböden were included in mapping them.

The foregoing statements describing the soils in the various columns apply to the zonal and intrazonal soils that make up the uplands and terraces rather than to the azonal soils indicated at the bottom of the key, which comprise alluvium and colluvium of very recent origin. The azonal soils, however, are placed in various columns of the key on the basis of drainage characteristics corresponding closely to those of other groups of soils.

The Bog soils were developed largely from decomposition of native vegetation. They have been further classified in table 12 on the basis of such characteristics as color, degree of decomposition, acidity, depth to water table, and vegetation.

TABLE 12.—*Chief characteristics of the organic soils*

Soil characteristics	Carlisle muck	Houghton muck	Houghton muck, shallow phase over sand
Color of surface soil	Black	Black	Black.
Color of subsoil	Brown	Brown	Brown.
Derived from	Swamp timber, sedges, grasses, reeds, and rushes	Sedges, grasses, reeds, and rushes.	Sedges, grasses, rushes, reeds, and swamp timber.
Degree of decomposition			
Surface soil	Well decomposed	Well decomposed	Well decomposed
Subsoil	Moderately decomposed	Moderately decomposed	Do
Depth to water table	3 feet or more	2½ to 3 feet or more	2 to 3 feet or more.
Acidity	Slight	Slight	Slight.
Character of recent vegetation	Tamarack, elm, buttonbush, marsh plants.	Marsh grass	Tamarack, buttonbush, and marsh plants.
Depth of organic soil	> 3 feet	> 3 feet	< 3 feet

Soil characteristics	Houghton muck, shallow phase over clay	Edwards muck	Kerston muck	Peat
Color of surface soil	Black	Black	Black	Dark brown
Color of subsoil	Brown	Dark brown	Dark brown	Brown.
Derived from	Sedges, grasses, rushes, reeds, and swamp timber	Sedges, grasses, rushes, reeds, and swamp timber.	Swamp timber, sedges, grasses, reeds, rushes, and alluvium	Sedges, grasses, reeds, rushes, moss, and ferns.
Degree of decomposition				
Surface soil	Well decomposed.	Well decomposed.	Well decomposed.	Slightly decomposed.
Subsoil	do	do	do	Do.
Depth to water table	2 to 3 feet or more.	2 feet or more	2 feet	1½ feet.
Acidity	Slight	Slight	Slight	Strongly acid.
Character of recent vegetation.	Tamarack, buttonbush, and marsh plants	Tamarack, buttonbush, and marsh plants.	Tamarack, buttonbush, and marsh plants.	Huckleberry, cinquefoil, moss, and briers.
Depth of organic soil	< 3 feet	1 to 3 feet	Variable	> 3 feet.

Key to the Soil Series

A. Zonal soils
- 1. Soils having rapid to very rapid internal drainage owing to gravelly or sandy substrata and good outlets.
  - (*a*) Soils having a moderately clayey B horizon but an unconsolidated sand and gravel substratum.
    - (1) Gray-Brown Podzolic soils: Tracy series.
    - (2) Prairie soils: Door and Byron series.
    - (3) Transitional moderately dark-colored soils originally developed under a prairie cover but with recent timber encroachment: Lydick series
  - (*b*) Soils having an open, porous, incoherent sandy substrata to a depth of 5 feet or more.
    - (1) Weakly developed Gray-Brown Podzolic soils: Coloma, Plainfield, and Bridgman series.
- 2. Soils having medium or good external and internal drainage.
  - (*a*) Soils having a fairly high percentage of clay in the B horizons and parent materials.
    - (1) Gray-Brown Podzolic soils: Galena, Hillsdale, and Lucas series.

B. Intrazonal soils.
- 1. Soils having medium external and slow internal drainage.
  - (*a*) Soils having clayey B horizons but unconsolidated sand and gravel substrata.
    - (1) Half Planosols (timber cover): Hanna series.
    - (2) Half Planosols (grass cover): Alida series.
  - (*b*) Soils having open, porous, incoherent sand substrata.
    - (1) Gray-Brown Podzolic soils: Berrien series (internal drainage slow only because of high water table).

B. Intrazonal soils—Continued.
- 2. Soils having slow external and internal drainage and subject to periodic saturation and drying during the process of soil formation.
  - (*a*) Soils having a relatively high percentage of clay throughout the solum and the parent material.
    - (1) Planosols (timber cover): Nappanee, Otis, and Fulton series.
  - (*b*) Soils having clayey B horizons and unconsolidated sand and gravel substrata.
    - (1) Planosols (timber cover): Willvale and Vaughnsville series.
  - (*c*) Soils having open porous sandy B horizons and clay substrata to depths of 2 feet or more.
    - (1) Ground-water Podzols: Allendale and Saugatuck series.
- 3. Soils having slow external and internal drainage and saturated most of the time.
  - (*a*) Soils having a relatively high percentage of clay throughout the profile and substrata.
    - (1) Half-Bog soils (timber cover): Brookston and Toledo series.
  - (*b*) Soils having clayey subsoils (M horizons) and unconsolidated sand substrata.
    - (1) Half-Bog soils: Newton, Granby, and Wauseon series.
- 4. Soils that were permanently saturated before being artificially drained.
  - (*a*) Soils having clayey M horizons and unconsolidated sand substrata.
    - (1) Half-Bog soils (partly Wiesenböden): Maumee series.
  - (*b*) Soils developed from peat.
    - (1) Organic soils: Carlisle, Houghton, Edwards, and Kerston mucks and peat (undifferentiated).

C. Azonal soils.
  - (*a*) Periodically saturated soils having slow drainage.
    - (1) Alluvial soils: Griffin series.
    - (2) Colluvial soils: Washtenaw and Wallkill series.

In reading the detailed descriptions of soil profiles in this report certain letters are used to designate certain types of horizons. The following paragraphs explain the meanings of these letters as used in this report.

The soil-forming processes are regulated or modified to a large extent by local conditions of relief and drainage. The local soil environment and the kind of layers that are formed are influenced by drainage conditions within the soil. If the surface slope of the land is such that the water runs off or percolates readily downward into the substratum, the soil may be said to be on "high ground." If the water draining from the high ground stands on the depressed areas and produces a marshy or swampy condition, the soil may be said to be on "low ground." Under the two conditions entirely different characteristics occur in the soil horizons or layers.

The three main horizons formed in high-ground soils may be defined as follows: (1) The A horizon has been leached of those basic materials which are most easily dissolved. The texture is more gritty or coarser because the finer clay has been carried down into the subsoil, which is known as the B horizon. (2) The B horizon usually is heavier in texture, owing to the accumulation of the clay particles of soil washed from the surface soil, or A horizon, provided the original parent material was uniform in texture. (3) The C horizon is the parent material of the same kind as that from which the A and B horizons have been formed. A subhorizon of C, which occurs in many places, is designated in this report as Y. It is a more friable, less highly leached layer lying below the B and above the C.

In this report the following horizon nomenclature is used for the poorly drained or dark-colored soils of depressions: The H horizon, in which the soil has been darkened in color by the accumulation of or-

ganic matter (humus); the M horizon, which consists of a modified mineral layer with no visible accumulation of humus; and the U horizon, which consists of unmodified geological material that may or may not be of the same kind as the parent material from which the H and M horizons were formed. In fresh alluvial soils there may be neither eluviation nor much accumulation of humus, and the deposited layers are called D horizons.

The following is a description of a profile of Tracy loam as observed in a virgin oak-hickory woods, sec. 23, T. 36 N., R. 3 W.

A_0. ¼ to 0 inch, partly decomposed dark-colored leafmold.

A_1. 0 to 2 inches, very dark-gray fairly well mixed organic and mineral matter decreasing in darkness and organic-matter content with depth.

A_2. 2 to 5 inches, brown mixture of organic and mineral matter that is loamy in texture.

A_3. 5 to 8 inches, light-brown or slightly yellowish brown loam having no well-defined structure and an intricate tangle of roots.

B_1. 8 to 11 inches, yellowish-brown loam having a fine-granular structure and considerable penetration of fine roots.

B_2. 11 to 16 inches, strong-brown or somewhat reddish-brown clay loam which crushes to yellowish-brown loam. Subangular nut and blocky structures are well developed, the particles ranging from ½ to 1 inch in diameter. The consistence of the horizon is moderately hard when dry, friable when moist, and moderately plastic and sticky when wet. The reddish-brown coloring is due to a colloidal film on the structure faces.

B_3. 16 to 24 inches, more friable and lighter textured clay loam than in B_2, strong brown, crushing to yellowish brown. The coarse crumblike particles are softer, less angular, and more easily crushed than the nutlike and blocky aggregates of B_2. The material is slightly plastic and sticky when wet. The B_3 horizon ranges from 20 to 33 inches in depth, owing to variations in the mineralogical composition of the parent material.

Y_1. 24 to 44 inches, interbedded strata of sand and clayey sand that is yellowish brown on the structure faces and that crushes to yellow.

Y_2. 44 to 57 inches, pale grayish-brown or pale yellowish-brown light clay loam containing a higher proportion of clay than Y_1.

C_1. 57 inches +, assorted outwash material consisting of pebbles of exotic rocks, such as granite, quartz, feldspar, and considerable Devonian shale of local origin. It also contains limestone and has an acid neutralizing value of 5 to 10 percent.

Small quantities of gravel and shale fragments are present throughout, especially from the B_3 horizon downward. The reaction of the leafmold is neutral, but below that the reaction is very strongly acid.

Other members of this series—Tracy fine sandy loam, Tracy loamy fine sand, and Tracy loamy sand—in the order named have increasing quantities of sand throughout the profile. In Tracy loamy fine sand and Tracy loamy sand the B horizons have relatively little accumulation of clay. Structure is moderately developed in Tracy loamy fine sand and almost entirely absent in Tracy loamy sand. Sufficient clay-forming minerals are present, however, to give these soils more body and a higher moisture-holding capacity than Plainfield fine sand, which Tracy loamy sand resembles. Tracy loamy sand differs from Plainfield fine sand also in being browner, probably owing to the presence of weathered shale throughout. The sandy substratum contains minute fragments of shale and of hornblende, feldspars, granites, and other exotic rocks, which indicate its close lithological relationship with the heavier textured members of this series.

The Door and Byron soils developed under a prairie vegetative cover have clayey B horizons and unconsolidated sand and gravel

substrata similar to those of the Tracy soils. The following description of Door loam was obtained in a grassy road cut in sec. 5, T. 35 N., R. 4 W. The original grass cover consisted of bluejoint turkeyfoot (big bluestem), prairie beardgrass (little bluestem), and bluejoint, but such grasses now grow only along fence rows, roads, and railroads.

A_1. 0 to 6 inches, dark-brown loam without definite structure.
A_1. 6 to 14 inches, similar to the above horizon with definitely thin-platy or phylliform structure.
A_2. 14 to 18 inches, dark-brown or brown loam having a fine-crumb structure. The particles are about one-fourth inch in diameter.
B_1. 18 to 22 inches, brown light clay loam having colloidal films of organic matter on the granular structural aggregates.
B_2. 22 to 30 inches, strong brown or yellowish-brown clay loam having a well-developed nut structure, particles ranging from one-fourth to three-fourths inch in diameter.
Y_1. 30 to 36 inches, strong-brown light clay loam becoming increasingly sandy and friable with depth. It has no well-defined structure.
Y_2. 36 to 54 inches, yellowish-brown clayey sand that is slightly sticky and plastic when wet.
Y_3. 54 to 100 inches, light-brown clayey sand that is highly siliceous but contains many fine shale fragments.
C_1. 100 inches +, sands containing considerable quantities of shale fragments and being definitely stratified. Elsewhere in the county this layer contains a large quantity of exotic glacial gravel including some limestone.

The reaction is very strongly acid throughout.

The Byron soil was developed under grass cover from glacial outwash material containing a high proportion of quartz sand with minor quantities of hornblende, feldspar, and other exotic minerals. Sufficient minute fragments of shale are present to produce a loamy soil throughout the A and B horizons as in Byron loamy fine sand, Tracy loamy fine sand, and Tracy loamy sand. These soils are developed from the same kind of outwash material, but the Tracy soils are light-colored Gray-Brown Podzolic soils and the Byron soils are dark-colored Prairie soils.

The Lydick soils originally were developed under a tall-grass prairie cover on which bur oaks have recently encroached. They are intermediate in soil character, particularly in color, between the Tracy and Door series. The A_1 horizon is medium dark brown and grades into a slightly lighter colored A_2 horizon containing somewhat less organic matter. The A horizon ranges from 9 to 12 inches in thickness, which is comparable to the thickness of the A horizons of the Tracy soils. The underlying B, Y, and C horizons generally are more yellowish brown but are otherwise similar to those of the Tracy series.

Members of the Coloma, Plainfield, and Bridgman series are developed from loose highly siliceous sands. There is little difference in texture between the various horizons of each, but there are marked color differences between the A, B, and C horizons.

The Coloma soils are developed in rolling upland positions where the glacial till contains a high proportion of quartz sand, small quantities of glacial rocks, and a few pockets or lenses of clay-forming minerals. The A horizon is brownish-yellow incoherent loamy fine sand and is underlain by yellow loose fine sand containing some glacial gravel. The soil is medium acid in reaction.

The Plainfield series is developed under a black oak and white oak timber cover from deeply leached medium-acid water-assorted sands, which in places have subsequently been reworked by the wind. Some of the land is level, and some is dunelike. The soil is similar in color and other characteristics to Coloma loamy fine sand, except that the clay coatings on the sand particles are thinner or absent and the acidity is considerably greater.

The Bridgman soil is developed from comparatively recently deposited and moderately leached sands of the high dunes bordering Lake Michigan. It had a black-oak timber cover and generally is moderately podzolized. Under virgin conditions the A_0 horizon contains considerable organic matter, is moderately dark, and is nearly neutral in reaction. This horizon is, on the average, 3 inches thick. It is underlain to a depth of 10 inches by light-gray or grayish-yellow strongly acid fine sand. In places a thin horizon of yellow or orange-yellow slightly cemented fine sand occurs at this depth. The underlying material consists of grayish-yellow incoherent fine sand that is nearly neutral to slightly alkaline in reaction at a depth of 30 to 36 inches.

The Galena, Hillsdale, and Lucas series include well-drained soils having a relatively high percentage of clay throughout the solum. The Galena soils are developed on moderately rolling morainic land under a mixed hardwood timber cover from moderately calcareous glacial till containing considerable shale and quartz sand. Carbonates have been leached to a depth of 3 to 6 feet. In color and physical condition the Galena soils resemble the Miami soils, which occur in other parts of Indiana, but differ from them in the variable degree of leaching and in the presence of a friable Y horizon between the B and C horizons in areas leached of carbonates to a depth of more than 3 feet. The parent material of Galena silt loam is dominated by shale; that of Galena loam contains more quartz sand and less shale, which results in a somewhat more friable soil throughout.

The following description of Galena silt loam was made in a virgin beech-maple woods in sec. 26, T. 37 N., R. 4 W.:

A_0. ½ to 0 inch, dark partly decomposed leaf litter in which angleworms have mixed the soil and organic matter in many places. The reaction is mildly alkaline.

A_{11}. 0 to 2 inches, moderately dark grayish-brown medium acid mellow silt loam without well-defined structure.

A_{12}. 2 to 4 inches, material that represents a penetration of highly organic dark grayish-brown silt loam into the underlying pale-yellow and grayish-yellow silt loam. This material is slightly acid.

A_2. 4 to 9 inches, grayish-yellow or yellowish-gray phylliform highly podzolized silt loam. The reaction is very strongly acid.

B_1. 9 to 16 inches, brownish-yellow friable silty clay loam breaking into angular blocky structure particles from one-fourth to one-half inch in diameter. As in the A_2 horizon the reaction is very strongly acid.

B_2. 16 to 22 inches, brownish-yellow clay loam that is slightly heavier and more compact than the overlying material. It breaks into blocky structure particles from ¾ to 1½ inches in diameter. The reaction is very strongly acid.

Y_1. 22 to 36 inches, brownish-yellow gritty silty clay loam that is slightly more friable than the material above. This horizon is moderately compact and hard when dry and has a very strongly acid reaction.

Y_2. 36 to 48 inches, brownish-yellow silty clay loam, which increases in colloidal content with depth. The lower part has a browner color,

owing to decrease in acidity and deposition of organic matter. The acidity ranges from very strong to slight, decreasing with depth.

C_1. 48 to 51 inches, yellow-brown slightly calcareous soft friable silty clay loam.

C_2. 51 inches +, olive-brown highly calcareous glacial till, exotic rocks, and mineral fragments consisting mainly of granites, gneiss, quartz, and feldspar, together with considerable shale of local origin.

The variations within areas of this soil are differences in depth to calcareous till, which in many places is as much as 7 feet, and in the development of thicker, more highly leached Y horizons. The heavy glacial drift is in many places deposited on lighter more sandy drift, which contains a lower proportion of carbonates of lime and magnesium.

The Hillsdale soils are developed under a mixed hardwood timber cover on moderately rolling land, from glacial till containing a fairly high proportion of quartz sandstone fragments. The Hillsdale soils differ from those of the Galena series in the following points: The texture of the surface soil is dominantly fine sandy loam, although loam is also recognized. The B horizon is variable in color and compactness but consists dominantly of yellow or brownish-yellow light clay or sandy clay loam. Yellow deep comparatively incoherent sands make up the underlying Y horizons. The soil is leached of carbonates of lime and magnesium to an average depth of 6 to 8 feet. The parent material consists of grayish-yellow moderately compact till that is about 50 percent or more quartz.

The Lucas soils are developed under a mixed hardwood timber cover from moderately calcareous lacustrine deposits of sand, silt, and clay. Lucas fine sandy loam has A, B, Y, and C horizons, but the subsoil is more compact and the profile contains a higher proportion of clay throughout than the Hillsdale soils. It is more closely related morphologically to Galena loam and Galena silt loam.

The intrazonal soils have well-developed soil characteristics that reflect the dominant influence of some local factor of drainage or relief over factors of climate and vegetation (*1*). In La Porte County they include two groups: Planosols and other imperfectly drained soils most of which have A, B, Y, and C horizons, and the Wiesenböden, Half-Bog, and Bog soils, which are developed under almost permanently saturated conditions and are characterized by the accumulation of considerable quantities of organic matter during the process of soil formation. The Wiesenböden and Half-Bog soils have the following horizons: The H horizon, which is characterized by a dark color and high organic-matter content; the M, or glei, horizon characterized, in the heavy-textured members, by a high accumulation of tough and plastic clayey material; and the U horizon, or underlying geological material, also affected by gleization in the upper part. Bog soils have various kinds of H horizons.

The soils having medium to slow natural drainage are intermediate in character between the true Planosols and the zonal soils. They have moderately well-developed soil characteristics but are subject to periodic saturation in the lower part of the subsoil. The following description of Hanna fine sandy loam is representative of this group. The profile examined is in sec. 20, T. 34 N., R. 4 W. The Hanna series comprises soils developed under a mixed hardwood, principally oak, cover from slightly calcareous water-laid glacial outwash material

that consists of exotic rocks, such as granite, quartz, and feldspar, together with a considerable quantity of shale fragments of local origin. The Hanna series belongs to the Tracy catena. Because of the variation in mineralogical composition, the soil varies in the content of clay accumulated in the B horizon.

A_0. ¼ or ½ inch to 0, dark brownish-gray loose moderately decomposed leaf litter. The reaction is neutral.

A_1. 0 to 3 inches, dark-brown or brown mellow very strongly acid fine sandy loam containing considerable organic matter thoroughly mixed with mineral matter.

A_{11}. 3 to 6 inches, light-brown fine sandy loam having considerable interpenetration of dark organic material. It has the same reaction as the material in the horizon above.

A_2. 6 to 9 inches, brownish-yellow fine sandy loam having a crumb structure and grading into the B_1. This horizon also has the same reaction as the material in horizon A_{11}.

B_1. 9 to 17 inches, brownish-yellow friable very strongly acid clay loam having a crumb structure. The material is slightly plastic and sticky when wet.

B_2. 17 to 26 inches, yellow very strongly acid sandy clay loam or heavy loam becoming increasingly friable with depth. A nutlike structure is well developed in most places.

Y_1. 26 to 48 inches, rust-stained gray and yellow loose incoherent loamy fine sand. The reaction is very strongly acid.

Y_2. 48 to 54 inches, lenses of rust-stained, mottled gray and yellow heavy clay loam containing some coarse sand and fine gravel. This material is somewhat less acid than that in the horizon above.

Y_3. 54 to 62 inches, brownish-gray medium-acid sand containing some rust-colored blotches and stains.

C. 62 inches +, calcareous stratified gravel and sand containing sandstone, granite, quartz sand, feldspar, and shale.

Hanna fine sandy loam as mapped along the border of the Kankakee marsh has a moderate to very small proportion of clay in the B horizon. This soil is formed from sands with a very high proportion of quartz containing only moderate quantities of shale but many minute fragments of feldspar and other exotic minerals.

The Alida soils are members of the Lydick catena, developed from geologic materials similar in character to those giving rise to the Hanna series. Originally they had a prairie cover, but hardwood timber has encroached recently upon the glassland. The A_1 horizon is medium dark grayish brown to a depth of 6 to 8 inches. The A_2 horizon is slightly lighter colored and lower in organic-matter content than the A_1. The underlying B, Y, and C horizons are similar to those of the Hanna series. Like the Hanna soils, these soils are developed on low flat land adjacent to the marshes where they are subject to waterlogging in the subsoils.

Developed under a mixed hardwood timber cover from water-laid sands having little clay-forming minerals the Berrien soils have no noticeable accumulation of clay in the B horizon, and the entire soil consists of incoherent sand or loamy sand. In places the sands have been reworked by wind. The Berrien soils belong to the Plainfield catena.

The Nappanee, Otis, and Fulton soils have slow internal drainage, are subject to periodic saturation during the process of soil formation, and have a high percentage of clay throughout the solum and parent material. Nappanee silt loam and Nappanee loam are developed under a mixed hardwood timber cover, consisting principally of beech and maple. Nappanee silt loam has developed from a very

compact glacial till containing a high proportion of shale; consequently, a very impervious blocky clay subsoil has formed. Following is a description of a profile of Nappanee silt loam taken from a virgin woods in sec. 17, T. 37 N., R. 4 W. The land is gently rolling to undulating.

A_1. 0 to 1 inch, dark-gray smooth strongly acid silt loam having a fine-crumb structure. There is no leafmold, but undecomposed leaves are abundant in the vicinity.

A_2. 1 to 3 inches, light brownish-gray very strongly acid silt loam with some interpenetration of organic material and a fine-crumb structure.

A_3. 3 to 7 inches, rust-stained light brownish-gray smooth very strongly acid silt loam having a phylliform structure. It contains brown iron manganese concretions ranging from very small to about one-fourth inch in diameter.

B_1. 7 to 11 inches, mottled brownish-yellow and gray moderately compact silty clay loam containing some glacial gravel. The material in this horizon is hard when dry and plastic and sticky when wet. The reaction is very strongly acid.

B_{21}. 11 to 20 inches, light brownish-gray very compact silty clay loam having a blocky structure, the particles ranging from ½ to 1 inch in diameter. The material in this horizon is very hard when dry and highly plastic and sticky when wet. The reaction is very strongly acid.

B_{22}. 20 to 24 inches, yellowish-brown and brown clay, slightly mottled with gray, having a blocky structure and somewhat greater compactness, plasticity, and stickiness than the B_{21} horizon. The material in this horizon is very strongly acid.

C_1. 24 to 30 inches, brownish-gray slightly calcareous silty clay. This till is moderately compact and has a nutlike to blocky structure.

C_2. 30 to 36 inches, brownish-gray highly calcareous compact till containing exotic glacial pebbles, consisting of granite and feldspar, and small quantities of shale fragments of local origin.

Brown iron-manganese concretions are common on the surface and throughout the surface soil of Nappanee silt loam.

Nappanee loam is similar in character but contains variable quantities of sand mixed with the A and B_1 horizons to a maximum depth of 15 inches.

Members of the Otis series are developed under a mixed hardwood beech-maple timber cover on level land, from moderately heavy glacial till. The soil character of the A and B horizons is similar to that of the Nappanee soils, but the B horizon is less compact and contains a lower proportion of clay. A more friable Y horizon generally lies between the B and the C horizons, which contains variable quantities of sand. The underlying calcareous till contains considerably less clay than that of Nappanee silt loam. Otis silt loam is intermediate in heaviness between Nappanee silt loam and Otis loam, the latter soil being derived from till containing a somewhat higher proportion of quartz sand and a lower proportion of shale than Otis silt loam.

Fulton fine sandy loam is developed (under a beech-maple timber cover) from lacustrine sand, silt, and clay, like those of Lucas fine sandy loam, generally deposited along old drainageways. This soil has A, B, Y, and C horizons and is leached of lime carbonate to a depth of 3 to 6 feet. The parent material consists of stratified sand, silt, and some clay.

The Willvale series consists of very slowly drained Planosols developed under a mixed hardwood timber cover on glacial outwash from low-lying slightly calcareous stratified sand, silt, and some

gravel, containing considerable shale fragments of local origin. The soil has A, B, Y, and C horizons with variable quantities of clay accumulated in the B horizon. Willvale loamy fine sand has an only moderately coherent clay loam to sandy clay loam B horizon. The B horizons of Willvale loam and Willvale fine sandy loam are heavier textured than the B horizon of the Willvale loamy fine sand. The soil is leached of carbonates to a depth of 5 to 7 feet or more. The Willvale soils are the most poorly drained of the Tracy catena.

The coastal beach bordering Lake Michigan consists of yellowish-gray sand that has little or no soil profile. Vaughnsville loam is the product of a fluctuating ground water level. It has a mixed hardwood timber cover and is developed in level to low slightly convex land. It has a reddish-brown surface soil to an average depth of 20 inches, containing a high proportion of iron. The upper part of the subsoil is mottled gray and yellow and contains some dark-brown iron concretions. The underlying material consists of mottled gray and yellow incoherent sand like that beneath the Maumee soils. This soil has slight accumulation of clay, but the iron content gives the soil considerable plasticity and stickiness. The reaction ranges from strongly acid to nearly neutral throughout.

Allendale loamy fine sand is a Ground-Water Podzol that is somewhat less strongly developed than Saugatuck loamy fine sand. It is level to undulating. This soil is formed from water-laid sand high in quartz overlying heavy clay at a depth of 2 to 3 feet. The clay consists dominantly of till, but in a few places it is of lacustrine origin. The A horizon to a depth of 1 foot is brownish-gray to brown loamy fine sand. It is underlain by incoherent mottled gray and yellow loamy fine sand. In some places where the sand is thicker, a thin horizon of unmottled sand lies immediately below the A horizon. At the point of contact with the underlying clay, an orange, yellow, and gray iron-stained horizon is developed, which is slightly cemented in a few places, especially when exposed to the air. The clay is very compact, bluish gray, highly plastic, and sticky, and it generally contains some exotic gravel. It is moderately calcareous from 3 to 4 feet below the surface.

Saugatuck loamy fine sand is a strongly developed Ground-Water Podzol with a thin nearly black A_1 horizon, a light-gray to pale lavender-gray A_2, a thin dark coffee-brown organic-iron B_1 horizon, and a cemented rusty-brown loamy sand B_2 horizon. Clay underlies the sandy parent material in most places at less than 40 inches below the surface.

The Wiesenböden and Half-Bog soils are those developed almost or entirely under permanent saturation in marshes, swamps, and seepy areas. They vary widely in character, depending on the degree of saturation and the character of the parent materials. In La Porte County no attempt was made to distinguish accurately between Wiesenböden and Half-Bog soils.

The Brookston and Toledo series represent Half-Bog soils that have a high percentage of clay throughout.

The following description of a profile of Toledo silty clay examined in a cultivated field in sec. 17, T. 37 N., R. 4 W., is representative

of this group. The Toledo soils are developed in depressions on lacustrine flats under nearly permanent saturation.

H_1. 0 to 6 inches, dark brownish-gray slightly acid silty clay that develops a loose friable mulch under cultivation. Owing to the high clay content and shrinkage of the colloids, large fissures occur in the cultivated soil on drying.

H_2. 6 to 10 inches, slightly rust-stained dark-gray compact silty clay that is very plastic and sticky when wet and hard when dry. The blocky structure particles are covered with black colloidal films. The reaction is neutral.

M_1. 10 to 15 inches, mottled gray and yellow rust-stained very plastic and sticky silty clay, in which the dark organic coloration fades. The soil breaks into angular blocks ranging from 1½ to 6 inches or more in diameter. As in the horizon above, the material in this horizon is neutral in reaction.

M_2. 15 to 24 inches, mottled gray and yellow tough plastic silty clay with little or no penetration of organic matter. Like the material above, this material is neutral in reaction.

M_3. 24 to 60 inches, mottled gray and yellow mildly alkaline very smooth waxy clay.

U_1. 60 inches +, calcareous clay.

The Brookston soils are developed under periodic saturation in irregular elongated many-lobed swales and depressions in the formerly wooded uplands. Brookston silty clay associated with Nappanee silt loam has a shallow medium-acid H horizon, generally ranging from 8 to 12 inches in thickness. Where the depressions are very narrow and shallow, conditions have not been very favorable for the accumulation of organic matter. The underlying M horizons are very tough and plastic when wet and impervious to the movement of moisture. The underlying calcareous till generally lies less than 3 feet below the surface.

Brookston silty clay loam associated with the Otis and Galena soils has a thicker H horizon and less plasticity than Brookston silty clay. It is nearly neutral in reaction. The underlying horizons are less plastic and sticky than the overlying material.

The Wauseon soils are Half-Bog soils associated in depressions with the Allendale soils. The upper part of the soil consists of a veneer of somewhat sandy soil overlying heavy calcareous lacustrine clay. The thickness of water-laid sand ranges from 1½ to 3 feet. The H horizon consists of dark brownish-gray loam or fine sandy loam about 18 inches thick overlying mottled gray and yellow, rust-stained loam or fine sandy loam, which extends to the underlying clay. This soil is nearly neutral in reaction throughout.

The Newton and Granby soils of La Porte County have clayey subsoils overlying incoherent sandy substrata. Most of the Newton and Granby soils elsewhere do not have much clay in the subsoil horizons. The Granby series includes approximately neutral soils developed in depressions from lacustrine deposits of sand and silt. Granby loam contains sufficient clay-forming minerals within the soil and derived in part from adjacent high-ground soils to develop a moderately heavy clay loam M horizon. The dark-colored organic horizon ranges from 12 to 18 inches in thickness and is underlain by the mottled gray and yellow clay loam M horizon extending to a depth of 25 or more inches. The underlying material consists of stratified sands and silts that are neutral to slightly alkaline in reaction. Granby fine sandy loam is developed from more sandy materials; consequently, little accumula-

tion of clay has taken place in the M horizon. The original vegetation on the Granby soils probably consisted of grasses, sedges, and water-loving trees.

Large bodies of the Newton soils (Half-Bog—perhaps some Wiesenböden included) are in the area known as Hauk Prairie where timber probably never grew. These soils are characterized by unusually high acidity. Most of them occupy extensive flats, but many small areas occur in slight depressions bordering the adjacent light-colored soils. The H horizon, to a depth of 8 inches, is dark brownish gray. It is underlain by a dark-brown layer extending to an average depth of 15 inches, where it grades into a mottled gray and yellow clay loam M horizon. Clay accumulation in this horizon is not typical of the Newton series. Here it is due to the content of Devonian shale in the outwash deposits. Stratified assorted sand occurs at average depths of 4 feet. The acidity in most places is close to pH 4.8 from the surface to a depth of 3 feet. In places in the Kankakee Basin, the pH value rises to 5.5 below a depth of 3 feet. In many places within the Lake Michigan Basin the Newton soils are associated with members of the Granby series. Here, they are less acid in reaction and in many places approach neutrality at a depth of 3 feet. Newton loamy fine sand occurs only in the Lake Michigan Basin where the parent materials consist dominantly of quartz sand; consequently the soil is incoherent loamy sand throughout.

Of the soils developed under permanent saturation, members of the Maumee series are the only mineral soils represented; the rest are organic soils. The Maumee soils probably can be classed as Half-Bog soils, although a fair part of the area probably was never forested. Actually it seems as though part of the Maumee soils as mapped are Half-Bog soils and part are Wiesenböden.

The Maumee soils have dark-gray mineral H horizons containing a moderate accumulation of organic matter to a depth of 15 to 24 or more inches, and ranging in texture from clay loam to loamy fine sand. Originally, a considerable part of these soils may have had a shallow layer of muck, perhaps 6 inches thick, on the surface. Subsequently this was incorporated with the mineral soil by tillage operations. Such changes have been observed within 10- to 20-year periods. The more sandy members of this series belong to the Plainfield catena and are developed from stratified and assorted fine sand consisting primarily of quartz. Having this type of parent material, the M horizon consists of mottled gray, yellow gray, or rust-colored loamy fine sand grading to gray fine sand, which may be slightly calcareous at a depth of about 4 feet. A layer of reddish-yellow or orange-yellow sand generally lies just above the calcareous parent material. This layer is typical of the Maumee series.

The Maumee soils associated with the Tracy and Door soils of the outwash plains are formed from slightly calcareous to neutral sand containing small quantities of gravel and Devonian shale. The Maumee soils developed from such material range in texture from clay loam to fine sandy loam and the mottled gray and rust-stained yellow or brown M horizons range from clay loam to sandy clay loam. The accumulation of clay is variable in occurrence and depth, but it probably extends to an average depth of 24 to 30 inches. The underlying horizons are dominantly slightly yellowish-gray fine sandy loam that

is neutral in reaction and contains some slightly calcareous material at a depth of 3½ to 5 feet.

Typically, the Maumee soils are slightly acid or neutral in reaction. Approximately 2 percent of the Maumee soils of this county are neutral; that is, they have a pH value of 7.0 in the surface soil. Probably 90 percent of the soils range from pH 5.0 to 6.0 in the 6-inch surface soil and are approximately neutral at a depth of 3 feet. This range in acidity is characteristic of soils mapped in the Maumee series in this part of Indiana.

Houghton muck is a nearly neutral organic (Bog) soil developed from a sedge-grass type of vegetation. The following description of a profile of this soil was observed in sec. 27, T. 37, R. 2 W.:

H_1. 0 to 7 inches, black granular well-decomposed muck having a 1-inch surface mat of grass roots.

H_2. 7 to 12 inches, brown or black moderately compact well-decomposed muck breaking horizontally into large lumps. A few brown fibrous remnants of roots are present.

H_3. 12 to 24 inches, black or dark-brown well-decomposed and macerated smooth organic mass that is soft and pasty when wet. This horizon contains considerable well-decomposed remnants of stems and roots.

H_4. 24 to 45 inches, dark-brown well-decomposed pasty muck containing considerable fibrous material.

H_5. 45 to 60 inches, brown moderately decomposed sedge peat.

There is little difference in color or degree of decomposition between the Houghton and Carlisle mucks, although in the latter the water level may be slightly lower, decomposition somewhat further advanced, and the surface horizons deeper and darker. Woody remnants occur throughout the soil mass of Carlisle muck indicating that the recent vegetative cover consisted of trees, which were largely tamarack, birch, elm, maple, and basswood.

Edwards muck is similar in color, character, state of decomposition, and vegetative cover to Carlisle muck. It is underlain within 3 feet of the surface by soft gray shelly calcareous marl.

Kerston muck is developed in alluvial bottom lands where it receives occasional depositions of sand and silt. This material may be laid down in layers separated by strata of organic material or the organic and mineral materials may be mixed.

Peat deposits consist of raw practically undecomposed organic materials developed under a high water table. They are very highly acid in reaction. The present vegetation consists of cinquefoil, huckleberry, ferns, moss, cotton grass, and briers, together with a border of button bush and a few tamarack trees. In most places the surface soil is a brown or black shallow layer of moderately decomposed fibrous organic matter. It is underlain by a fibrous spongy mass of comparatively undecomposed plant material.

The azonal soils are products of recent deposits of alluvial and colluvial material. They have accumulated under two conditions. The alluvial soils consisting of material laid down along natural stream courses are members of the Griffin series, and the colluvial soils consisting of colluvial-alluvial deposits in kettle holes in the moraine and on the glacial outwash plains are members of the Washtenaw, Wallkill, and Pinola series. This group of soils is of minor extent, occupying about 3.8 percent of the area of the county. They are relatively high in fertility and contain adequate supplies of nitrogen, organic matter, and moisture where they occupy positions that

are susceptible to drainage. They occur under imperfect drainage conditions, and frequently are too poorly drained for crop production. The Griffin series comprises neutral soils having brownish-gray highly blotched and stained surface soils that grade at a depth of 10 or 12 inches into mottled gray and yellowish-brown subsoils. The texture varies widely, depending on the source and character of the sediments.

The Washtenaw series includes light-colored colluvial deposits laid down on darker older soils in very shallow to deep kettle holes. Natural drainage conditions range from fair to very poor. The grayish-brown fresh deposits of silt and loamy material average about 2 feet in thickness, and, in many places where erosion has been severe, these deposits are much thicker and more variable in mechanical composition.

The Wallkill series comprises grayish-brown freshly deposited silts and loams of colluvial origin deposited on organic soils. These soils for the most part are poorly drained, but, where much material has been deposited, drainage conditions may be better.

The Pinola soil is associated with the Prairie soils representing the Door and Lydick series. Here the fresh colluvial material is moderately dark brown and overlies a somewhat darker older soil. The kettle holes generally are moderately well drained, owing to the permeable character of the substratum on outwash plains. Most of the kettle holes are less than 5 feet deep and the colluvial material ranges from 2 to 5 feet in thickness. The underlying soils are practically unmottled, indicating moderately good natural drainage.

MANAGEMENT OF THE SOILS OF LA PORTE COUNTY

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The farmer should know his soil and have a sound basis for every step in its treatment. Building up the productivity of a soil to a high level, in a profitable way, and then keeping it up is an achievement toward which the successful farmer strives. As in any other enterprise, every process must be understood and regulated in order to be uniformly successful, and a knowledge of the soil is highly important. Different soils present different problems as to treatment, and these must be studied and understood, in order that crops may be produced in the most satisfactory and profitable way.

The purpose of the following discussion is to call attention to the deficiencies of the several soils of the county, and to outline in a general way the treatments most needed and most likely to yield satisfactory results. No system of soil management can be satisfactory unless in the long run it produces profitable returns. Some soil treatments and methods of management may be profitable for a time but ruinous in the end. One-sided or unbalanced soil treatments have been altogether too common in the history of farming in the United States. A proper system of treatment is necessary in making a soil profitably productive.

PLANT NUTRIENTS

Table 13 shows the approximate total content of nitrogen, phosphorus, and potassium and the weak-acid soluble or available phos-

phorus and potassium in the different soils of La Porte County, expressed in pounds of elements in the 6- to 7-inch plowed surface soil of an acre, estimated at 2,000,000 pounds for the mineral soils and 1,000,000 pounds for the mucks.

TABLE 13.—*Approximate quantities of nitrogen, phosphorus, and potassium in certain soils of La Porte County, Ind.*

[Elements in pounds per acre of surface soil, 6 to 7 inches deep]

Soil type	Total nitrogen	Total phosphorus [1]	Total potassium	Weak acid soluble phosphorus [2]	Weak acid soluble potassium [2]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Nappanee silt loam	2,800	570	39,700	15	170
Nappanee loam	2,600	440	34,600	25	120
Allendale loamy fine sand	1,800	350	22,500	25	25
Otis silt loam	2,800	660	37,300	20	185
Otis loam	2,400	610	33,800	25	170
Galena silt loam	2,400	520	39,100	45	200
Galena loam	2,000	440	33,400	15	135
Hillsdale loam	2,000	610	35,300	60	150
Hillsdale fine sandy loam	1,800	520	28,600	70	75
Coloma loamy fine sand	1,000	440	23,100	80	25
Willvale loam	2,400	960	29,400	95	175
Willvale fine sandy loam	2,400	700	27,600	35	135
Fulton fine sandy loam	2,000	610	26,400	80	70
Berrien loamy fine sand	1,800	610	23,200	165	65
Willvale loamy fine sand	1,800	440	29,000	35	65
Vaughnsville loam	4,800	1,570	17,800	10	85
Hanna loam	1,800	700	29,400	30	185
Hanna fine sandy loam	2,000	700	25,900	25	75
Alida loam	2,400	700	29,200	45	275
Alida fine sandy loam	3,000	870	32,600	45	210
Tracy loam	2,200	700	31,900	60	200
Tracy fine sandy loam	1,600	610	28,100	70	90
Lydick loam	3,000	870	32,400	45	150
Lydick fine sandy loam	2,200	700	28,100	60	170
Lucas fine sandy loam	1,600	610	33,600	95	65
Tracy loamy fine sand	1,400	700	27,600	95	85
Tracy loamy sand	1,200	520	24,400	60	60
Plainfield fine sand	1,200	610	24,300	260	100
Brookston silty clay	6,400	1,400	37,200	120	200
Brookston silty clay loam	7,600	1,750	39,000	155	195
Wauseon loam	4,800	960	33,300	50	175
Toledo silty clay	6,400	1,000	42,400	130	195
Granby loam	5,200	870	26,000	60	75
Granby fine sandy loam	4,200	790	30,000	20	85
Maumee clay loam (neutral)	7,200	1,400	19,000	50	130
Maumee clay loam (acid)	6,800	1,600	19,200	45	120
Maumee loam (neutral)	5,000	1,050	31,000	45	75
Maumee loam (acid)	5,800	870	25,200	50	90
Maumee loam (acid ferruginous)	6,600	2,400	22,700	45	60
Maumee fine sandy loam (acid)	6,600	1,310	22,000	60	120
Maumee loamy fine sand (acid)	8,000	960	22,800	80	85
Maumee fine sandy loam, mucky phase (acid)	19,200	1,570	18,000	60	170
Newton loam	6,200	960	22,400	80	125
Newton fine sandy loam	5,400	870	24,600	70	135
Newton loamy fine sand	4,200	610	25,000	50	45
Saugatuck loamy fine sand	3,600	520	21,200	85	65
Door loam	5,000	2,310	31,300	70	210
Door fine sandy loam	4,000	700	28,600	35	60
Byron loamy fine sand	3,400	610	22,400	60	20
Pinola silt loam	7,200	1,920	33,500	150	370
Washtenaw silt loam	4,000	960	39,500	50	195
Griffin silty clay loam	7,000	2,180	23,200	35	120
Griffin loam	4,600	1,220	18,700	25	100
Carlisle muck	20,000	1,660	3,100	20	85
Houghton muck	25,300	1,140	3,500	30	85
Edwards muck	22,900	1,440	2,700	40	180
Kerston muck	23,700	870	7,700	10	90
Peat	23,900	740	4,700	50	210

[1] Soluble in strong hydrochloric acid (specific gravity 1.115)
[2] Soluble in weak nitric acid (fifth normal).

The total plant-nutrient content is more indicative of the origin and age of a soil than of its fertility. This is particularly true of potassium. The amount of total potassium in a soil is seldom indica-

tive of its need for potash. Some Indiana soils that have more than 30,000 pounds of total potassium to the acre in the 6-inch surface layer fail to produce corn satisfactorily without potash fertilization, because so little of the potassium they contain is available.

The total content of nitrogen is generally indicative of the need for nitrogen, although some soils with a low content may have a supply of available nitrogen sufficient to grow a few large crops without the addition of that element. Soils having a low total nitrogen content soon wear out, as far as that element is concerned, unless the supply is replenished by the growing and turning under of legumes or by the use of nitrogenous fertilizer. The darker soils are generally higher in organic matter. Organic matter and nitrogen are closely associated in the soils of Indiana; hence it is a fairly safe rule that the darker the soil, the richer it is in nitrogen.

The amount of total phosphorus in ordinary soils is usually about the same as that shown by a determination with strong acid. For this reason a separate determination of total phosphorus has been omitted. In Indiana the supply of total phosphorus usually indicates whether or not a soil needs phosphatic fertilizers.

The amount of phosphorus soluble in weak acid is considered by many authorities to be a still better indication of the phosphorus needs of a soil. The depth of a soil may modify its need for phosphates. Everything else being equal, the more weak-acid soluble phosphorus a soil contains, the less it is likely to need phosphate fertilizers. Where the weak-acid soluble phosphorus runs less than 100 pounds to the acre, phosphates are usually needed for high yields of crops.

The quantity of potassium soluble in strong or weak acid is to some extent significant. This determination, however, is not so reliable an indicator as is the determination for phosphorus, particularly with soils of high lime content. Sandy soils and muck soils are more often in need of potash than clay and loam soils. Poorly drained soils and soils with impervious subsoils usually need potash more than well-aerated deep soils.

The use of strong or weak acid in the analysis of a soil has been criticized by some, yet such analyses can more often be correlated with crop production than can analyses of the total elements of the soil. For this reason acid solutions have been employed in these analyses.

It must be admitted, however, that no one method of soil analysis will definitely indicate the deficiencies of a soil. These chemical data, therefore, are not intended to be the sole guide in determining the needs of the soil. The depth of the soil, the physical character of the horizons of the soil profile, and the previous treatment and management of the soil are all factors of the greatest importance and should be taken into consideration. Pot tests indicate that nitrogen and phosphorus are much less available in subsurface soils and subsoils than they are in surface soils. On the other hand, potassium in the subsoil seems to be of relatively high availability. Crop growth depends largely on the amount of available plant nutrients with which the roots may come in contact. If the crop can root deeply, it may be able to make good growth on soils of relatively low analysis. If the roots are shallow, the crop may suffer from lack of nutrients, particularly potash, even on a soil of higher analysis.

The better types of soils and those containing large amounts of plant-nutrient elements will endure exhaustive cropping much longer than the soils of low plant-nutrient content.

The nitrogen, phosphorus, and potassium contents of a soil are by no means the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the degree of acidity. Many soils that are very strongly acid will not produce well, even though there be no apparent lack of plant-nutrient elements. Although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect where calcium is deficient.

Table 14 shows the percentage of nitrogen and the acidity of certain soils.

Table 14.—*Percentage of nitrogen and acidity in certain soils of La Porte County, Ind.*

Soil type	Depth	Nitrogen	pH[1]	Average depth to neutral material	Indicated lime requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
	0–6	0.14	5.2		
Nappanee silt loam	6–18	.05	5.3	24	2–3
	18–36	.05	7.2		
	0–6	.13	5.7		
Nappanee loam	6–18	.06	5.8	31	2–3
	18–36	.04	6.1		
	0–6	.09	4.9		
Allendale loamy fine sand	6–18	.05	6.2	33	1–2
	18–36	.03	7.2		
	0–6	.14	5.4		
Otis silt loam	6–18	.07	5.0	54	2–4
	18–36	.04	5.3		
	0–6	.12	5.8		
Otis loam	6–18	.05	5.9	45	2–3
	18–36	.04	6.3		
	0–6	.12	5.3		
Galena silt loam	6–18	.05	5.6	48	2–4
	18–36	.04	5.6		
	0–6	.10	5.3		
Galena loam	6–18	.07	6.0	48	2–4
	18–36	.06	6.0		
	0–6	.10	5.8		
Hillsdale loam	6–18	.04	5.8	48	2–3
	18–36	.04	5.6		
	0–6	.09	5.9		
Hillsdale fine sandy loam	6–18	.04	5.7	54	2–3
	18–36	.06	5.6		
	0–6	.05	6.0		
Coloma loamy fine sand	6–18	.05	6.0	60	1–2
	18–36	.04	6.6		
	0–6	.12	4.9		
Willvale loam	6–18	.06	5.4	70	2–4
	18–36	.04	6.2		
	0–6	.12	4.9		
Willvale fine sandy loam	6–18	.06	4.8	75	4
	18–36	.04	5.1		
	0–6	.12	5.0		
Fulton fine sandy loam	6–18	.05	5.5	60	2–4
	18–36	.04	5.7		
	0–6	.09	5.0		
Berrien loamy fine sand	6–18	.10	5.2	75	3–4
	18–36	.06	5.2		
	0–6	.09	5.0		
Willvale loamy fine sand	6–18	.06	5.0	75	3–4
	18–36	.05	5.0		
	0–6	.24	6.7		
Vaughnsville loam	6–18	.15	6.8	40	------------
	18–36	.07	6.8		
	0–6	.09	5.1		
Hanna loam	6–18	.06	4.9	75	3–4
	18–36	.05	4.9		
	0–6	.10	4.9		
Hanna fine sandy loam	6–18	.09	4.9	75	4
	18–36	.05	4.8		

See footnotes at end of table.

TABLE 14.—*Percentage of nitrogen and acidity of certain soils of La Porte County, Ind.*—Continued

Soil type	Depth	Nitrogen	pH[1]	Average depth to neutral material	Indicated lime requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
Alida loam	0-6	.12	4.6	75	[illegible]
	6-18	.09	4.6		
	18-36	.04	4.8		
Alida fine sandy loam	0-6	.15	5.3	75	[illegible]
	6-18	.08	4.8		
	18-36	.04	4.5		
Tracy loam	0-6	.11	5.4	80	3-4
	6-18	.07	5.0		
	18-36	.06	4.8		
Tracy fine sandy loam	0-6	.08	5.5	80	2-3
	6-18	.05	5.7		
	18-36	.04	5.8		
Lydick loam	0-6	.15	5.4	80	3-4
	6-18	.09	5.0		
	18-36	.03	4.8		
Lydick fine sandy loam	0-6	.11	5.2	80	2-4
	6-18	.06	5.4		
	18-36	.06	5.3		
Lucas fine sandy loam	0-6	.08	4.5	80	4
	6-18	.05	4.8		
	18-36	.03	4.5		
Tracy loamy fine sand	0-6	.07	5.0	[2]	2-4
	6-18	.05	5.0		
	18-36	.04	4.9		
Tracy loamy sand	0-6	.06	5.3	80	2-4
	6-18	.05	4.8		
	18-36	.04	5.6		
Plainfield fine sand	0-6	.06	5.6	60	2-3
	6-18	.04	6.0		
	18-36	.05	6.6		
Brookston silty clay	0-6	.32	5.3	33	1-2
	6-18	.13	5.6		
	18-36	.07	6.6		
Brookston silty clay loam	0-6	.38	5.5	33	1-2
	6-18	.15	6.0		
	18-36	.10	7.2		
Wauseon loam	0-6	.24	6.4	25	------------
	6-18	.12	6.6		
	18-36	.05	7.3		
Toledo silty clay	0-6	.32	6.8	15	------------
	6-18	.12	7.0		
	18-36	.04	[3]		
Granby loam	0-6	.26	6.1	25	0-1
	6-18	.08	6.4		
	18-36	.05	6.9		
Granby fine sandy loam	0-6	.21	6.1	32	0-1
	6-18	.05	6.4		
	18-36	.07	6.9		
Maumee clay loam (neutral)	0-6	.36	6.1	18	------------
	6-18	.14	7.0		
	18-36	.07	[3]		
Maumee clay loam (acid)	0-6	.34	5.3	34	1-2
	6-18	.13	6.0		
	18-36	.08	7.0		
Maumee loam (neutral)	0-6	.25	6.4	16	------------
	6-18	.22	7.0		
	18-36	.04	[3]		
Maumee loam (acid)	0-6	.29	5.5	38	1-2
	6-18	.11	6.0		
	18-36	.07	6.6		
Maumee loam (acid ferruginous)	0-6	.33	5.6	30	1-2
	6-18	.06	6.0		
	18-36	.02	7.0		
Maumee fine sandy loam (acid)	0-6	.33	5.3	42	2-3
	6-18	.12	5.7		
	18-36	.05	6.3		
Maumee loamy fine sand (acid)	0-6	.40	5.2	40	1-2
	6-18	.27	6.4		
	18-36	.14	6.9		
Maumee fine sandy loam, mucky phase (acid)	0-6	.96	5.0	42	2-3
	6-18	.40	5.5		
	18-36	.15	6.2		
Newton loam	0-6	.31	5.0	80	4
	6-18	.20	4.9		
	18-36	.10	5.1		
Newton fine sandy loam	0-6	.27	4.7	80	4
	6-18	.16	4.8		
	18-36	.08	4.7		

See footnotes at end of table.

TABLE 14.—*Percentage of nitrogen and acidity in certain soils of La Porte County, Ind.*—Continued

Soil type	Depth	Nitrogen	pH[1]	Average depth to neutral material	Indicated lime requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
	0–6	.21	5.0		
Newton loamy fine sand	6–18	.13	4.9	70	3–4
	18–36	.08	5.4		
	0–6	.18	4.8		
Saugatuck loamy fine sand	6–18	.07	4.9	80	4
	18–36	.04	5.2		
	0–6	.25	5.0		
Door loam	6–18	.17	5.0	100	4
	18–36	.08	5.1		
	0–6	.20	5.3		
Door fine sandy loam	6–18	.12	5.2	80	4
	18–36	.07	5.1		
	0–6	.17	5.0		
Byron loamy fine sand	6–18	.12	5.1	80	4
	18–36	.06	5.0		
	0–6	.36	4.7		
Pinola silt loam	6–18	.37	5.1	80	4
	18–36	.42	5.4		
	0–6	.20	6.4		
Washtenaw silt loam	6–18	.05	6.2	80	1–2
	18–36	.15	6.1		
	0–6	.35	6.8		
Griffin silty clay loam	6–18	.20	6.6	40	....
	18–36	.10	6.7		
	0–6	.23	5.8		
Griffin loam	6–18	.15	6.0	40	0–2
	18–36	.08	6.7		
	0–6	2.00	6.4		
Carlisle muck	6–18	2.20	6.6	40	....
	18–36	1.80	6.9		
	0–6	2.53	5.5		
Houghton muck	6–18	2.60	5.9	55	0–2
	18–36	1.60	6.2		
	0–6	2.29	5.5		
Edwards muck	6–18	3.04	6.4	25	....
	18–36	.05	([3])		
	0–6	2.37	6.5		
Kerston muck	6–18	2.40	6.5	40	....
	18–36	.95	6.8		
	0–6	2.39	5.0		
Peat	6–18	2.25	5.0	80	....
	18–36	2.04	5.3		

[1] pH determined colorimetrically.
[2] Undetermined.
[3] Calcareous.

The acidity is expressed as pH, or approximate hydrogen-ion concentration. For example, pH 7 is neutral, and a soil with a pH value of 7 contains just enough lime to neutralize the acidity. If the pH value is more than 7, the soil is alkaline in reaction, and there is some lime (or some other base) in excess. From pH 6 to pH 7 indicates medium to slight acidity, and from pH 5.6 to pH 6 shows medium acidity. If the pH value runs below 5.6 the soil is strongly acid. As a rule, the stronger the acidity the more a soil needs lime. Samples were taken from the surface soil (0 to 6 inches), from the subsurface soil (6 to 18 inches), and from the subsoil (18 to 36 inches). It is important to know the reaction, not only of the surface soil, but of the lower layers, of the soil as well. Given two soils of the same acidity, the one with the greater acidity in the subsurface layer is in greater need of lime than the other. The slighter the depth of acid soil, the less likely it is to need lime. Those soils having the greater clay content need a greater amount of lime to neutralize them, given the same degree of acidity. The less phosphorus, calcium, and magnesium the soil contains, the more likely it

is to need lime. It is well to remember that sweetclover, alfalfa, and red clover need lime more than other crops. As it is advisable to grow these better soil-improvement legumes in the rotation, it is in many places desirable to lime the land in order that sweetclover or alfalfa will grow.

In interpreting the soil survey map and soil analyses, it should be borne in mind that a well-farmed, well-drained, well-fertilized, well-manured soil that is naturally low in fertility may produce larger crops than a poorly farmed soil that is naturally higher in fertility.

SOIL MANAGEMENT

For convenience in discussing the management of the several soils of this county, they are arranged in groups according to certain important characteristics that indicate that in many respects similar treatment is required. For example, several of the silt loams of the uplands and terraces, which have practically the same requirements for their improvement, may be conveniently discussed as a group, thus avoiding the repetition that would be necessary if each were discussed separately. Where different treatments are required they are specifically pointed out. The reader should study the group including the soils in which he is particularly interested.

LIGHT-COLORED LOAMS AND SILT LOAMS OF THE UPLANDS AND TERRACES

The light-colored loams and silt loams of the uplands and terraces in La Porte County comprise the loams and silt loams of the Galena, Nappanee, and Otis series and the Hillsdale loam in the uplands, and the loams of the Tracy, Lydick,[9] Alida, Hanna, Willvale, and Vaughnsville series. They occupy 85,760 acres, or about 23 percent of the total area of the county, and are about equally divided between the uplands and terraces.

The light-colored loams are classed with the silt loams rather than with the sandy loams because, for the most part, their crop adaptations and soil-management problems coincide more nearly with the heavier types of soil.

The gullied and eroded phases of the Hillsdale and Tracy loams, other untillable land, and the steeper parts of the slope phases of the Galena, Hillsdale, and Tracy loams that are unfit for farming are considered separately at the end of this discussion on soil management.

DRAINAGE

The Tracy, Lydick, Galena, and Hillsdale soils are naturally fairly well to well drained. The Alida, Hanna, and Willvale loams on the terrace and the Otis and Nappanee loams and silt loams on the uplands, are naturally imperfectly to poorly drained, especially Nappanee silt loam, which has a very tough heavy subsoil. Because of the tight subsoil, this soil is difficult to drain and tile lines should be spaced less than 3 rods apart and 2½ to 3 feet deep. The apparently impervious subsoil will improve gradually under artificial drainage and become more pervious. Tile drainage facilitates soil aeration,

[9] Although Lydick loam is classed in Soils and Crops as a dark-colored soil, it is intermediate in color and for purposes of management is best included in this group.

which helps to make the plant nutrients in the soil available and encourages deeper rooting of crops. This enables them to withstand drought better, as well as to obtain more plant nutrients from the subsoil.

A gray or mottled subsoil indicates insufficient drainage. Without tile drainage such soils cannot be satisfactorily managed, and no other beneficial soil treatment can produce its full effect.

Where land to be tiled is very flat, great care must be exercised in tiling in order to obtain an even grade and uniform fall. Nothing less accurate than a surveyor's instrument should be used in establishing grade lines, and the individual lines should be accurately staked and graded before the ditches are dug, to make sure that all the water will flow to the outlet with no interruption or slackening of the current. The rate of fall may be increased toward the outlet, but it should never be decreased without inserting a silt well, as checking the current may cause the tile to become choked with silt. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling, thus insuring proper operation of the drains from the beginning.

LIMING

All the soils of this group are acid in the surface soil and upper part of the subsoil, and they are more or less in need of liming. The lime requirement should be determined by soil acidity tests for each particular area. If the farmer himself cannot make the test, he can have it made by the county agricultural agent or by the Purdue University Agricultural Experiment Station at La Fayette. A strongly acid soil will not respond properly to other needed treatments until after it has been limed. The failure of clover to develop satisfactorily indicates a need of lime, although lack of thriftiness in clover may also be due to lack of available plant nutrients, insufficient drainage in the heavy or naturally wet soils, or a poor physical condition of the soil, owing to lack of organic matter. Ground limestone usually is the most economical form of lime to use, except where marl is handy. As a rule, the first application should be at least 2 tons of ground limestone, or its equivalent in other liming material, to the acre. After that, 1 ton to the acre every second or third round of the crop rotation will keep the soil reasonably sweet. Where alfalfa or sweetclover is to be grown on an acid soil, a heavier application of limestone may be needed.

ORGANIC MATTER AND NITROGEN

All the soils of this group are naturally low in organic matter and nitrogen. The lighter the color of the soil, the lower the content of these important constituents. Constant cropping, without adequate returns to the land, and more or less soil erosion are steadily making matters worse. In many places the original supplies of organic matter have become so reduced that the soil has lost much of its native mellowness and easily becomes puddled and baked. This condition in a large measure accounts for the more frequent failures of clover and the greater difficulty in obtaining proper tilth

in such areas. Wherever these evidences of lack of organic matter and nitrogen occur, the only practical remedy is to plow under more organic matter than is used in the processes of cropping. Decomposition is going on constantly and is necessary in order to maintain the productivity of the soil. Decomposing organic matter must also supply the greater part of the nitrogen required by crops. For this reason legumes should provide as much as possible of the organic matter to be plowed under. To accomplish this satisfactorily, the land must first be put in condition to grow clover and other legumes. This means liming wherever the soil is acid. Wet lands must also be tile drained. Clover or some other legume should appear in the rotation every 2 or 3 years; as much manure as possible should be made from the produce that can be utilized by livestock; and all produce not fed to livestock, such as cornstalks, straw, and cover crops, should be plowed under directly. Legumes are the only crops that can add appreciable quantities of nitrogen to the soil and this only in proportion to the amount of top growth that is plowed under, either directly or in the form of manure. Wherever clover seed is harvested, the threshed haulm should be returned to the land and plowed under. Cover crops should be grown wherever possible to supply additional organic material for plowing under. Seeding rye or a rye and winter vetch mixture as a cover crop in September on cornland that is to be plowed the following spring is good practice for increasing organic matter and conserving nitrogen. It is important to have some kind of growing crop on these soils during the winter, in order to take up the soluble nitrogen that otherwise would be lost through leaching. Without living crop roots to take up the nitrates from the soil water, large losses will occur between crop seasons through drainage, and soil erosion will be more active on slopes and hillsides. Losses from drainage and erosion may be greatly lessened by a good cover crop of winter rye on all land that otherwise would be bare during the winter. The rye or rye and vetch should be run down with a heavy disk and plowed under before the rye heads—at any rate in ample time to prepare a proper seedbed for the crop that follows.

CROP ROTATION

If they are properly fertilized and, where needed, limed and tile drained, these soils will produce satisfactorily all the ordinary crops adapted to the locality. On account of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another. Corn, wheat or oats, and clover or mixed clover, alfalfa, and timothy constitute the best short rotation for general use on these soils, especially when the corn can be cut and the ground can be disked and properly prepared when wheat is the small-grain crop to follow. Corn, soybeans, wheat or oats, and mixed hay constitute an excellent 4-year rotation for these soils. The two legumes in the rotation will build up the nitrogen supply if parts of the produce are left on the ground or returned either directly or in the form of manure. When soybeans are first introduced, the seed should be carefully inoculated with the proper variety of nitrogen-gathering bacteria, and inoculated seed should be sown at least 2 years in succession. The soybean straw,

if not used as feed, should be spread on the wheatland in winter. This will help the wheat and reduce winter injury and in addition help to insure a stand of clover or other seeding for the hay crop. The soybean is not only a good crop in itself, but it also adds some nitrogen to the soil and improves it for the crop that follows. If more corn is required, as on livestock farms, the 5-year rotation of corn, corn, soybeans, wheat or oats, and mixed hay may be used satisfactorily where the second corn crop can be given a good dressing of manure. Where corn follows corn, as in the 5-year rotation, and where soybeans follow corn, as in both the 4-year and 5-year rotations suggested, cover crops of sweetclover or rye, for plowing under the following spring, should be seeded in each corn crop to help maintain fertility. Where clover sown alone is uncertain in any of these rotations, it has proved to be a good plan to sow a mixture of seeds made up of about 3 pounds of red clover, 4 pounds of alfalfa, 2 pounds of alsike, and 2 pounds of timothy to the acre. Alfalfa is more drought-resistant than clover, and alsike and timothy are more acid tolerant. Since the red clover and alfalfa are the more valuable constituents of the mixture, conditions for their growth should be made as favorable as possible by liming soils that are acid, by maintaining a good physical condition through frequent incorporations of organic matter, and by providing proper drainage.

Alfalfa and sweetclover may be grown by themselves on the better drained and more friable areas, if the soil is properly inoculated and sufficiently limed to neutralize harmful acidity. These two crops are especially sensitive to soil acidity. Alfalfa is preferable for hay, and sweetclover is excellent for pasture and for soil improvement. Special literature on the cultural requirements of these crops can be obtained from the Purdue University Agricultural Experiment Station.

FERTILIZATION

All the soils of this group are naturally low in phosphorus, and the available supplies of this element are so low that the phosphorus required by crops should be wholly supplied in applications by manure and commercial fertilizers. The nitrogen supplies in these light-colored soils are too low to meet satisfactorily the needs of corn, wheat, oats, and other nonleguminous crops; and provisions for adding nitrogen should be an important part of the program for their improvement. The total quantities of potassium in these soils are large, but the available supplies are likely to be low after some years of cropping. In most places the addition of some potash fertilizer would be profitable, especially where little manure is applied.

The problem of supplying nitrogen has been discussed in connection with provisions for supplying organic matter. Legumes and manure are the logical and only really practical means of supplying the greater part of the nitrogen needed by crops, and they should be largely relied on for this purpose. A livestock system of farming, with plenty of legumes in the crop rotation, is, therefore, best for these soils. Inclusion of some nitrogen in the fertilizer, however, generally proves profitable in the production of wheat, regardless of its place in the rotation. Even though wheat follows soybeans or other legumes, it should receive some nitrogen in the fertilizer applied at seeding time to start the crop properly, because the nitrogen in

the residues of immediately preceding legumes does not become available quickly enough to be of much help to the wheat in the fall. The material must first decay, and that does not take place to a great extent until the following spring.

Phosphorus is the mineral plant-nutrient element in which all these soils are most deficient. The only practical way to increase the supply of phosphorus is through the application of purchased phosphatic fertilizers, and it will prove profitable to supply the entire phosphorus needs of crops in this way. In rotations of ordinary crops, producing reasonable yields, it may be considered that 20 pounds of available phosphoric acid to the acre are required each year. Where manure is applied, it may be estimated that each ton supplies 5 pounds of phosphoric acid; therefore, a correspondingly smaller quantity need be provided in the form of commercial fertilizer. In short rotations it is usually most practical to divide the fertilizer between the grain crops.

Although large total supplies of potassium are present in these soils, the readily available potash is inadequate for the production of maximum crops. Its availability may be increased by good farm practices, including proper tillage, tile drainage of wet areas, the growing of deep-rooted legumes, and the plowing under of liberal quantities of organic matter. The better these practices are carried out and the larger the quantity of manure applied, the less potash fertilizer need be purchased.

The quantity of potash that should be applied as fertilizer depends on the general condition of the soil and the quantity of manure used. The flat poorly drained areas of the gray soils are most likely to be in need of potash fertilizer. On soils that have become run down, any program for their improvement should include potash fertilizer, at least until such time as considerable quantities of manure can be applied or until the general condition of the soil has materially improved.

In the practical fertilization of these soils, so far as the ordinary field crops are concerned, the manure should usually be plowed under for the corn crop; but where wheat is grown a part of the manure, about 2 tons to the acre, may be applied profitably to this crop as a top dressing during the winter. Such use of a part of the manure not only helps the wheat and lessens winter injury but also helps to insure a stand of clover or other seeding in the wheat. As a rule, the manured cornland should also receive some available phosphate in the hill or row at the rate of about 100 pounds to the acre. Without manure, cornland should be given 100 to 200 pounds to the acre of a phosphate and potash mixture, like 0–14–6 or 0–12–12, applied in the hill or row. For hill-planted corn, hill fertilization is most efficient, provided the application is made with a fertilizer attachment which places the fertilizer in two short bands, one on each side of the hill. Wheatland should be given from 200 to 300 pounds to the acre of a high-analysis complete fertilizer, at least as good as 2–12–6. On poor soils, or where the wheat is backward in the spring, a top dressing of about 100 pounds to the acre of a soluble nitrogen fertilizer should be applied soon after growth begins. Such top dressing usually will add from 5 to 7 bushels per acre to the yield. Where corn and wheat are included in the rotation and the land is properly fertilized, little fertilizer will be needed on other crops. Oats and

soybeans, as a rule, are less responsive to fertilizer, and soybeans are rather sensitive to injury to germination where fertilizer is used. Where it is necessary to fertilize soybeans directly, the application should be made so as to avoid contact with the seed. With the development of the rapid soil and plant-tissue tests, it generally will be possible to obtain a test of the particular situation as a guide in formulating the fertilizer program.

LIGHT-COLORED SANDY SOILS OF THE UPLANDS AND TERRACES

The group of light-colored sandy soils of the uplands and terraces includes the fine sandy loams of the Hillsdale, Willvale, Fulton, Hanna, Alida, Tracy, Lydick,[10] and Lucas series; the loamy fine sands and loamy sands of the Tracy, Willvale, Allendale, Coloma, and Berrien series; and Plainfield fine sand. Together, these light-colored sandy soils occupy 76,736 acres, or about 20 percent of the total area of the county. They are naturally low in phosphorus, nitrogen, and organic matter, except Alida fine sandy loam, which contains supplies of the two last-named constituents in the surface soil. They are all low in available potassium, and most of them need liming.

Coloma loamy fine sand and the associated Hillsdale soils are used successfully for apple and peach orchards if the sites are chosen carefully so as to have a northern exposure and good air drainage. Table 15 gives the percentage of production of apples, peaches, and grapes of a full crop for the years 1917–40, as reported by M. M. Austin, Head, Department of Statistics (agricultural), Purdue University Agricultural Experiment Station.

TABLE 15.—*Percentage of production of apples, peaches, and grapes of a full crop in Indiana, 1917–40* [1]

Year	Apples	Peaches	Grapes	Year	Apples	Peaches	Grapes
	Percent	*Percent*	*Percent*		*Percent*	*Percent*	*Percent*
1917	55	47	87	1930	30	([2])	90
1918	35	15	76	1931	77	96	86
1919	30	50	93	1932	58	72	95
1920	76	100	88	1933	60	0	90
1921	29	55	32	1934	68	61	90
1922	72	81	100	1935	70	91	84
1923	68	53	87	1936	40	25	56
1924	58	0	50	1937	98	95	95
1925	70	0	62	1938	34	27	14
1926	95	100	95	1939	98	95	79
1927	48	70	65	1940	45	0	98
1928	58	80	72				
1929	31	70	71	Average for 24 years	58.5	[3] 55.8	77.3

[1] Based on 4 to 10 reports per county. [2] No report. [3] Average for 23 years.

DRAINAGE

Most of these sandy soils are so loose and open to a considerable depth that natural drainage is excessive, and they are very apt to be droughty. Allendale loamy fine sand may be benefited by some tile drainage where the clay subsoil lies near the surface. Willvale fine sandy loam and Willvale loamy fine sand are naturally im-

[10] Although Lydick sandy loam is classed as a dark-colored soil in Soils and Crops, it is intermediate in color and for purposes of management is best included with this group.

perfectly drained because of their low position and may be benefited by tiling where open ditches are not adequate to remove surplus water.

LIMING

These sandy soils are all more or less acid and in need of liming before they can grow clover and other lime-loving legumes; therefore liming generally is the most profitable investment the farmer can make (pl. 2, *A*).

Allendale loamy fine sand is acid to an objectionable extent only in the surface soil and a light application of lime to give lime-loving legumes a start is all that is needed. Coloma loamy fine sand, also, is not very strongly acid.

The quantity of lime needed on any particular area can be determined easily by a soil-acidity test. If the farmer himself cannot make the test, he should have it made by the county agricultural agent or by the Purdue University Agricultural Experiment Station. If the soil is acid it is unwise to attempt its improvement without liming, as the successful growth of clover and other deep-rooted legumes is an important step in the process of soil improvement. Ground limestone is the most economical form of lime to use in most places. Near areas of Edwards muck or the marl beds, marl obtained from these areas may be used instead of limestone. Since marl varies greatly in lime content, it should be tested for acid-neutralizing value in order to determine how much of it is needed to equal a ton of ground limestone.

ORGANIC MATTER AND NITROGEN

All the light-colored soils are deficient in organic matter and nitrogen. The light-colored sandy soils are particularly in need of organic matter to increase their water-holding capacity and thus protect crops from droughts. These two deficiencies accompany one another, and both should receive the first attention of farmers on these soils.

On the very poor sandy areas, the cheapest and most effective first aid, if little money is available, is to grow a crop of soybeans. Where grown for the first time, soybeans must be artificially inoculated with their special nitrogen-fixing bacteria. In addition, the land should receive an application of superphosphate or a mixture of phosphate and potash. The seed should be drilled at the rate of 2 bushels to the acre. Immediately after harvesting the soybeans, the ground should be disked lightly and seeded to rye or a mixture of rye and winter vetch, fertilized with a high-grade complete fertilizer. If the soybean straw is not fed, it should be spread on the rye in the fall or winter. If a combine harvester with a straw spreader attachment is used, the straw may remain in the field and will not interfere with the seeding of rye. The rye should be plowed under the following spring and the land again seeded to inoculated soybeans.

If these poor sandy soils can be limed and well fertilized with phosphate and potash, they will produce good yields of alfalfa and

A, Effect of lime on a stand of alfalfa on Plainfield fine sand in a corn-soybeans-wheat-hay rotation, Sand Experiment Field, 1940. *B*, Effect of phosphate and potash on yields of hay on limed and manured Newton fine sandy loam, Pinney-Purdue Experiment Farm, 1940, in an experiment begun in 1920 in which a corn-oats-clover rotation was followed, the land uniformly limed, and for each corn crop a quantity of manure applied commensurate with the amount of produce harvested: *a*, Lime and manure—1,872 pounds of hay per acre; *b*, lime, manure, and 180 pounds of 0–20–0 fertilizer for preceding corn crop—3,280 pounds of hay, *c*, lime, manure, and 180 pounds of 0–20–20 on preceding corn crop—3,872 pounds of hay

sweetclover, and these crops can be profitably used to build up the supplies of organic matter and nitrogen. There is no better crop than sweetclover for green manure.

A very important item that should be remembered in the management of sandy soils is that they use up organic matter very rapidly. Their loose, open, excessively aerated condition favors rapid decomposition and oxidation, or the burning out of the soil organic matter. For this reason, more than ordinary quantities of organic materials, such as manure, crop residues, specially grown green-manure crops, and cover crops should be constantly added. The land should never be left without a cover crop. The cover crop will also reduce losses from leaching and erosion.

CROP ROTATION

To make the most satisfactory progress in the improvement of these soils, the land should be limed and put in condition to grow clover, alfalfa, or sweetclover. In most places 2 tons of ground limestone to the acre will counteract the harmful acidity. The liming should be done a year before seeding if possible. Alfalfa is most valuable for these soils, as its deep rooting system enables it to withstand drought much better than clover. The alfalfa seed must be inoculated. Full instructions concerning the culture of alfalfa, sweetclover, and soybeans may be obtained from the Purdue University Agricultural Experiment Station.

An excellent rotation for these sandy soils, after liming, is corn, soybeans, wheat or rye, and alfalfa for 1 or more years. Wheat is a better cash crop than rye if the nitrogen supply is adequate. A light winter dressing of manure on the wheatland will increase the yield greatly and help to obtain a stand of alfalfa. Two tons of manure to the acre on wheatland at the Sand experiment field near Culver has increased the yields of wheat about 5 bushels to the acre as an average for the last 15 years. A top dressing in April of a soluble nitrogen carrier supplying from 15 to 20 pounds of nitrogen to the acre has increased yields of wheat 3 to 8 bushels an acre.

An extra field that remains in alfalfa for several years is a wise provision against failure to obtain stands in some years on the land in rotation. On the Sand experiment field located in Plainfield fine sand, the most successful stands of alfalfa have been obtained from late July or early August seedings on disked small-grain stubble land.

On unlimed areas that will not grow clover or alfalfa, a rotation of corn, soybeans, and rye may be used, but extra quantities of manure and/or fertilizer will be needed in order to obtain satisfactory yields. Potatoes may be used in this rotation by plowing under the soybean crop, seeding to rye, and plowing the rye under in the spring before planting the potatoes.

The sandy loams produce high-quality potatoes. When grown on old well-manured alfalfa sod and when well fertilized, potatoes are a profitable cash crop for supplying home markets, and they may well be fitted into the rotation in place of some of the corn. On the more sandy areas, cantaloups for home markets are a good cash crop.

On Hillsdale fine sandy loam and that part of Coloma loamy fine sand that is fit for farming, increasing consideration is being given to other than grain and hay systems of cropping. These soils are

adapted to apples, peaches, grapes, blackberries, and other bush fruits, and with proper management commercial fruit growing is a profitable enterprise.

FERTILIZATION

The fact that these sandy soils are deficient in nitrogen emphasizes the importance of growing legumes on them, as has been suggested. Barnyard manure, of course, should be utilized to the fullest possible extent, and all unutilized crop residue should be returned to the land. Fertilizer nitrogen cannot be profitably purchased to a large extent. Land devoted to such crops as wheat, rye, and potatoes, however, should always receive some nitrogen in fertilizer form, even when these crops follow legumes.

Phosphates are needed in considerable quantities, because all these soils are low in phosphorus. They are also low in available potassium and require potash fertilizers, the amount depending on the quantity of manure used. Manure supplies about 10 pounds of potash per ton. Plate 2, *B* shows the response of alfalfa to phosphate and potash on Newton fine sandy loam.

The scheme of fertilization on these soils should be such as to supply all the phosphorus required by the crops grown. As a rule, most of the manure should be applied on land for the small grain or for the young clover or alfalfa after the grain harvest, or on sods several months before plowing for corn or potatoes, at least on the more sandy soils. On areas with heavier subsoils, the common practice of applying manure through the winter before plowing for corn is justified. For small grains the land should receive from 200 to 300 pounds to the acre of 2–12–6 fertilizer, or 3–12–12 if manure is scarce. Cornland should receive 100 pounds to the acre of 0–12–12 in the row, and potatoes will respond profitably to at least 500 pounds of 3–12–12 applied in the row. Cantaloups should be heavily fertilized. With such fertilization and a constant and abundant supply of organic matter, including legumes, these soils can be made very productive.

DARK-COLORED SANDY SOILS

The group of dark-colored sandy soils includes the fine sandy loams of the Maumee, Newton, Granby, and Door series and the loamy fine sands of the Maumee, Newton, Byron, and Saugatuck series. Together, these soils occupy about 65,152 acres, or about 17 percent of the total area of the county and are located mostly in the Kankakee Valley where the Maumee and Newton soils predominate.

DRAINAGE

Most areas of the Door and Byron soils have sufficient natural drainage and in general benefit from attention to increasing their water-holding capacity by the incorporation of additional organic matter.

The Granby, Maumee, Newton, and Saugatuck soils are naturally poorly drained, owing to their relatively low position and flat surface; and, because of an excessively high water table, especially in spring, they need artificial drainage. Most of the areas have been provided with "dredge" ditches to lower the general level of the water table. Where additional drainage is needed, it can be provided readily by

additional ditches or large tile at wide intervals, as water moves freely in the sandy subsoil.

LIMING

For the most part, Granby fine sandy loam is only slightly acid and is not much in need of liming. The sandy Maumee soils are medium to strongly acid in the surface soil and upper part of the subsoil; therefore they generally need liming, at least for clover and other lime-loving legumes. According to pH tests, from 1 to 2 tons of ground limestone should be applied on Maumee loamy fine sand and from 2 to 3 tons on Maumee fine sandy loam. The Newton, Door, and Byron soils are naturally very strongly acid and so much in need of liming that this should be one of the first steps in any soil-improvement program. At the Pinney-Purdue Experiment Field near Wanatah, on Newton fine sandy loam, an application of 4 tons of ground limestone an acre made in 1920 has produced increases in yields of crops valued at $97.94 up to the end of 1939. The crop rotation included corn, oats, and mixed clover and timothy hay. Corn was valued at 50 cents a bushel, oats at 30 cents a bushel, and hay at $8 a ton. Equivalents of the ground limestone, in marl and other forms of lime, have produced practically the same results.

ORGANIC MATTER AND NITROGEN

The Maumee and Newton soils have fair to adequate supplies of organic matter and nitrogen; and, if reasonable care is taken to return manures and crop residues, these constituents may be satisfactorily maintained. The Byron soil, and some areas of the Door and Saugatuck soils are not high in organic matter and nitrogen; therefore more attention should be given to the maintenance of these constituents.

CROP ROTATION

The Maumee and Newton soils are best adapted to extensive systems of farming, and corn and oats have been by far the dominant crops on these soils. The Newton soil, however, must be heavily limed before much can be expected from it. Where good drainage is provided, livestock enterprises could be more generally emphasized, and more attention should be given to better crop rotations. Although corn should generally remain the major crop, soybeans might well be substituted for much of the oats; and, on areas where sufficient drainage has been provided, the hardy varieties of winter wheat might come in for more attention. For such conditions good rotations are: Corn, small grain, and mixed hay; corn, corn, small grain, and mixed hay; and corn, corn, soybeans, small grain, and mixed hay. Maumee loamy fine sand and Maumee fine sandy loam are also adapted to mint, potatoes, and various truck crops.

For the drier situations on the Door and Byron soils, the following two rotations are good, provided the land is sufficiently limed to produce clover: Corn, wheat or oats, and clover; and corn, soybeans, wheat or oats, and clover. With more thorough liming, alfalfa and sweetclover could be more extensively grown to good advantage. These well-drained soils are also suited to potatoes, melons, and various small fruits.

FERTILIZATION

All these dark-colored sandy soils are more deficient in available potash than in any other fertilizer element. They are naturally fairly well to very well supplied with nitrogen, especially the darker soils. The available supplies of phosphorus are low to medium.

In fertilizing crops on these soils, the supplying of potash should be given the chief emphasis, except on Door fine sandy loam where phosphate seems equally important. On farms, which also have lighter colored soils, most of the manure should be used on the lighter colored soils and dependence placed on commercial fertilizer high in the mineral elements for the dark-colored soils, as the latter are not so much in need of the organic matter and nitrogen supplied by manure as the former.

In the general plan for fertilizing these dark-colored soils, cornland should receive from 75 to 100 pounds an acre of 0–10–20 or 0–8–24 placed on both sides of the hill, or twice as much drilled continuously in the row. For wheat and other small grains, the land should receive from 200 to 300 pounds per acre of 3–12–12 or 2–8–16 drilled with the seed. Oats are not so responsive to fertilizer as are other small grains and might be given about the same fertilization as corn, especially if followed by a seeding of clover. For most truck crops, 500 pounds per acre of 0–8–24 is recommended.

DARK-COLORED LOAMS AND HEAVIER SOILS OF THE UPLANDS AND TERRACES

The group of dark-colored loams and heavier soils of the uplands and terraces includes all the Brookston, Wauseon, Pinola, Washtenaw, and Toledo soils; the loams of the Door, Granby, Newton, and Maumee series; and Maumee clay loam. Although it carries considerable light-colored overwash, Washtenaw silt loam is included in this group because of the dark-colored subsoil. Altogether, these soils occupy 86,784 acres, or about 24 percent of the county. Door loam and Maumee loam are by far the most important types, occupying 33,216 acres and 27,072 acres, respectively. This group includes the most fertile soils of the county, but large areas of soils in this group need considerable liming and potash fertilization to make them most profitably productive.

DRAINAGE

Door loam is fairly well drained in most places and generally can be managed satisfactorily without additional tile drainage. The other soils of this group are naturally wet, owing to their positions on low terraces or in depressions. In the extensive areas of the Maumee and Newton soils, which are almost flat and lie only slightly above the Kankakee River bottoms, large deep dredge ditches have been provided. These ditches have lowered the water table and made tile drainage more practicable. In the depressions, occupied by such soils as the Brookston, Wauseon, and, to some extent, the Pinola and Washtenaw, some open ditches and tile drainage are essential to satisfactory farming operations. In plans for additional tile drainage, provision must be made to insure sufficient fall and a uniform or increasing current, so that silt will have no opportunity to settle and choke the tile.

LIMING

For the most part, the Granby, Toledo, Wauseon, and Brookston soils, part of Maumee loam, and Maumee clay loam are only slightly acid and not in need of liming. The acid parts of Maumee loam and Maumee clay loam (and these are dominant) show considerable acidity in the surface and upper part of the subsoil and generally need some liming, especially for clover. The Newton soils are very strongly acid and should receive initial applications of 3 to 4 tons of ground limestone per acre or its equivalent in some other form of lime. The Door and Pinola soils also need considerable liming. Washtenaw silt loam seems to be less acid, but it generally needs some liming. Whenever there is doubt, the soil should be tested for acidity.

ORGANIC MATTER AND NITROGEN

These soils are well supplied with organic matter and nitrogen; and, if reasonable care is taken in their management, no special provisions for supplying these constituents will be necessary for a long time. Washtenaw silt loam, however, the lighter colored areas of Granby loam and Door loam, and all the very heavy soils will be benefited by the incorporation of additional organic matter. Even on the dark-colored soils, the burning of crop residues is a wasteful practice that should be avoided.

CROP ROTATION

These soils are among the best in the county, and if proper attention is given to liming and draining where needed, they will produce all the ordinary crops adapted to this section. They are especially well suited to corn, and this should generally be the major crop. Among the rotations that may be used satisfactorily are the following: Corn, wheat or oats, and clover; corn, corn, wheat or oats, and clover; corn, soybeans, wheat or oats, and clover; and corn, corn, soybeans, wheat or oats, and clover. To guard against the hazards of winter-killing of clover, it is generally advisable to seed some timothy with the clover. Whenever clover fails, soybeans make a satisfactory substitute crop for legume hay. On well-drained areas of the slightly acid soils and on Door loam, after thorough liming, alfalfa and sweetclover may be grown successfully, and their use should be encouraged wherever they can be utilized economically.

FERTILIZATION

These soils are naturally well supplied with nitrogen, and, if legumes are included in the crop rotation, the fertilizer need not contain nitrogen for the ordinary field crops, except wheat. The total and available supplies of phosphorus are higher than in the light-colored soils. The supplies should not be drawn on heavily, however; and, as a rule, most of the phosphorus required by the crops should be supplied to the land. On farms having both light-colored and dark-colored soils, most of the manure should be applied to the light-colored soil, where the organic matter and nitrogen of the manure are most needed. Cornland generally should receive from 100 to 150 pounds to the acre of a phosphate and potash mixture in the hill or row. This may range from 0–20–10 on the heavier soils, especially where some manure is used, to 0–8–24 for the lighter tex-

tured areas of the Newton and Maumee soils. Wheatland should receive from 200 to 300 pounds to the acre of a complete fertilizer, such as 2–12–6. Such fertilization will also help the clover crop. As oats will seldom respond to nitrogen in fertilizer, where they are the small-grain crop, a phosphate and potash mixture will usually be sufficient.

MUCKS

The group of mucks comprises the predominantly organic soils, except peat. They are Houghton, Carlisle, Edwards, and Kerston mucks, which total 31,744 acres, or about 8 percent of the area of the county. A large part of this area represents Houghton muck, which is among the important soils of the county. Profitable management of the muck soils involves careful drainage, where drainage is at all possible; the growing of suitable crops; and the application of large quantities of potash. In most places, some phosphate also will be profitable, especially after the land has been cropped for several years. The need for potash fertilizer is especially urgent on the typical mucks, which are naturally very low in both total and available potassium. The silty mucks are much better supplied with both phosphorus and potassium and may not require much fertilizer for some time.

The question is sometimes asked whether muck soils can be improved by burning. They cannot be permanently improved by burning, and they may be seriously and permanently injured. Burning adds nothing; on the other hand, it destroys much valuable organic matter and nitrogen. The mineral plant-nutrient elements concentrated in the ash remains are not to be considered as gain. These elements are soon exhausted, and the land is left in a poorer condition than it was before burning, because of the destruction of organic matter and the consequent lowering of the land level to such an extent, in many places, as to make drainage more difficult.

DRAINAGE

In the improvement of muck soils, the first requisite is proper drainage. As a general rule, the water table should be lowered to a depth of 2 to 3 feet below the surface. For meadows, a depth of 2 feet to the water table may be enough for best results. Muck soils drain freely if the water has a chance to get away. It is not necessary for ditches and tile lines to be so close together as in the fine-textured soils. Ordinarily, the distance between tile lines or lateral ditches should be about 100 feet. Whether tile or open ditches should be used depends on local conditions. If the subsurface material is sufficiently firm to hold tile in place, tiling is preferred, as open ditches are always a nuisance. In extensive areas, large open outlet ditches may be necessary. These, however, should not be deeper than is necessary to keep the water table at a proper level to meet the needs of crops.

Most muck areas receive considerable surface and seepage waters from the higher lands adjoining, and the plan of drainage should provide for the removal of such waters as well as the excess water that falls on the muck areas. The first thing to be done is to cut a ditch or lay a line of tile along the edge of the marsh next to the higher land adjoining. This will catch the seepage from the higher land

and make drainage of the rest of the muck area comparatively easy, provided, of course, that a suitable outlet can be obtained. In areas bordering on lakes sufficient drainage for cultivated crops may be impossible.

It has been stated that muck soils should not be too deeply drained, because the crops grown on them are apt to suffer from lack of water. Where tile drainage is used, however, the lines of tile must be placed deep enough so that subsequent settling of the soil will not leave them too near the surface, as muck settles considerably within the first few years after drainage, and allowance for this should be made. The ultimate aim should be to have the water table about 3 feet below the surface. Great care should be exercised in establishing an even grade for each line of tile, so that the flow of water will be uniform. Fine materials, which wash in at the tile joints, settle easily and will soon clog the tile if the grade line is uneven. As a rule, nothing smaller than 5-inch tile should be used for muck soils. It is a good plan to cover the tile with a layer of straw or grass a few inches thick before filling the ditches, as this will keep much fine material out of the tile while the ground is settling.

In some places it may be desirable to raise the water table when the dry season of the year approaches, especially for shallow-rooted crops. This can be done by temporarily damming the outlets of the ditches or by blocking the tile outlets, thus holding the water table up until sufficient rains come again.

LIMING

Carlisle, Edwards, and Kerston mucks are only slightly acid and not in need of liming. Edwards muck is underlain by marl, which is a good source of liming material for acid soils. Some areas of Houghton muck may be benefited by applications of lime because of the greater depth to which acidity extends in this type.

CROPS

When properly drained and fertilized, muck soils may be satisfactorily used for all the field and garden crops adapted to the climatic conditions of this section, except wheat, oats, and barley, as well as many crops that ordinarily are not adapted to the soils of the uplands. Most of the truck and vegetable garden crops do better on properly managed mucks than on mineral soils. It may be said, therefore, that the farmer who has muck soil on his farm has a much greater range in the choice of crops that he may grow.

For the general farmer, corn is the best crop for muck soils, as these soils can endure cropping with corn longer than any other soils, except rich overflow bottom lands. With the addition of plenty of potash and some phosphate, corn may be grown on fields of muck most of the time. It is necessary, however, to use early varieties of corn in order to escape early frosts. For a change in the cropping system, such crops as soybeans, rye, and mixed timothy and alsike, for meadow or pasture, are suggested. Potatoes also may be fitted into the rotation.

On the Pinney-Purdue muck experiment field near Wanatah, a 4-year rotation of corn, corn, soybeans, and potatoes is giving good results. During the 15 years since this experiment was begun, the crop

yields in this rotation have averaged 57.9 bushels of corn, 24.8 bushels of soybeans, and 134.6 bushels of potatoes to the acre. The fertilizer used is 0–8–24, and the standard application is 150 pounds to the acre in the row for corn and 300 pounds to the acre for potatoes. On a part of this field where the quantity of potash was doubled, the average acre yield of potatoes has been increased to 165.9 bushels; but the increases of the other crops have been small, averaging 5.7 bushels of corn and 1.5 bushels of soybeans.

The small grains are the least suitable crops for muck soils, because they are apt to produce a rank growth of weak straw and lodge badly. Liberal applications of potash will aid materially in producing stiffer straw. Other crops adapted to muck soils are mint, hemp, Sudan grass, millet, sorghum, buckwheat, sugar beets, turnips, and mangels. Of the truck crops, onions, cabbage, cauliflower, kale, rutabagas, celery, lettuce, parsnips, beets, carrots, and sweet corn do well on this kind of land, where proper drainage can be arranged and the crops are properly fertilized. Details concerning practices for the production of any particular crop can be obtained from the county agricultural agent at Crown Point or from the Purdue University Agricultural Experiment Station.

IMPORTANCE OF COMPACTING

One of the difficulties in managing muck soils is that they are apt to be too loose on the surface. In preparing the seedbed, therefore, it is important to pack the ground thoroughly by the use of a heavy roller, going over the field several times if necessary. Thorough compacting of the muck is not only better for the growth of crops, but it also aids materially in lessening the damage from early frosts.

FERTILIZATION

In the fertilization of muck soils, potash is of first importance. Nitrogen is present in great abundance; hence the addition of nitrogenous fertilizers is not required, except for early truck crops, which need readily available nitrogen, especially in late seasons when nitrification—the bacterial action that makes nitrogen available—does not begin early enough to supply these crops. For the grain and hay crops, the natural soil supplies of nitrogen become available fast enough to meet all needs. When first brought under cultivation, some mucks may produce a few good crops without the addition of potash, but the available potassium soon becomes exhausted, and the only recourse is to supply this element from outside sources.

For the common field crops, about 100 pounds of muriate of potash to the acre should be applied each year, or 200 pounds every other year. In many places, especially after several years of cropping, it will pay to add some available phosphate, and fertilizers, such as 0–8–24, 0–10–20, or even 0–20–20, may be desirable.

For truck crops, the rates of application of fertilizers should be much greater than for grain crops. For celery, some growers use as much as 2,000 pounds of fertilizer to the acre. For early planted crops, such as onions, lettuce, and cabbage, large quantities of complete fertilizer, such as 3–9–18 or 2–8–16, are used by many growers.

Farm manure may be used to supply potassium and phosphorus to these soils. On farms including both organic and mineral soils, however, the manure preferably should be applied to the mineral soils. The organic soils do not need the nitrogen and organic matter that manure supplies, whereas the mineral soils especially need these constituents. In some places the application of manure on raw muck soils will be helpful in supplying beneficial bacteria, which may be lacking, especially if the material is very raw or the land has always been very wet.

BOTTOM LANDS

The bottom lands of La Porte County, bordering the natural streams in narrow strips, consist of Griffin loam and Griffin silty clay loam. Together, these soils occupy 5,760 acres, or about 1 percent of the total area of the county.

The greatest difficulty in the management of these soils is to provide adequate drainage and to prevent damage from flooding.

Most of this land is not adapted to crop rotation. Much of it has been left in timber. Some of it is in bluegrass pasture, which does very well as these soils are only slightly acid to almost neutral. Where flooding is not too great a hazard, corn and other crops that can be grown under such conditions will do very well without much fertilization.

NONARABLE LAND

Nonarable land includes the eroded and gullied phases of Tracy, Galena, and Hillsdale loams, the blow-out phases of the Coloma and Plainfield fine sands, Bridgman fine sand, a large part of the slope phases of the Galena, Hillsdale, and Tracy soils, and the rolling phase of the Plainfield soil—totaling about 28,864 acres, or 7 percent of the area of the county. In addition, parts of the Washtenaw, Pinola, and other excessively wet soils that cannot be successfully drained are undesirable for ordinary farming. This land is of value mainly for forest or pasture. In some places slope phases of soils are being successfully tilled, but in general tillage of such areas has proved exceedingly destructive and should be discouraged. In many places terracing and contour cropping might be practical. Some areas that are unfit for tillage may be successfully utilized as pasture land. Many areas should be reforested with adapted trees and given protection from livestock. Areas mapped as peat are nonarable, because decomposition has not advanced far enough and the land is excessively wet.

SUMMARY

La Porte County is in the northwestern part of Indiana, bordering Lake Michigan. La Porte, the county seat, is 65 miles from Chicago. The total area of the county is 595 square miles.

The surface features consist of morainic ridges extending diagonally across the northern part of the State and roughly paralleling Lake Michigan. These ridges divide the sand and gravel plains of the Lake Michigan Basin from the broad outwash plains and marshes of the Kankakee Basin. The land forms are almost entirely the result of the Late Wisconsin glaciation, the underlying sedimentary rock having been covered to an average depth of 200 feet by the

moraine. A few natural streams have developed in the areas of most pronounced relief along the borders of the moraine. The Kankakee River, now a drainage canal, is the largest stream and flows through an area of gentle relief that lies only slightly higher than the Kankakee marsh. The elevation of the county ranges from 581 feet above sea level on the shore of Lake Michigan to 957 feet, the highest point on the morainic ridge north of La Porte.

Settlement of La Porte County began in 1829. The county was organized January 9, 1832, and it took its present form after Lincoln and Johnson Townships were added from St. Joseph County in 1850. La Porte is the county seat. The county had a population of 63,660 in 1940.

Proximity to Lake Michigan tempers the climate, which is characterized by moderately warm pleasant summers and moderately cold winters. The mean annual temperature is 49° F. An average of about 37 inches of precipitation, including about 51 inches of snow, falls annually. The average frost-free period is 150 days in the southern part of the county and 170 days in the northern part.

The agriculture is widely diversified. Ever since the early settlement of the county, mixed grain and livestock farming has been followed, with corn and wheat as the principal farm crops. Agriculture developed most rapidly in the northwestern part. The marshland of the Kankakee Basin was the last land to be brought under cultivation after drainage was effected by dredged ditches, about 1900. This resulted in a great increase in the acreage of corn, the crop to which this land is best suited. Wheat has always been widely grown, especially on the broad prairies. The acreage has gradually declined in the last few years.

With the rapid increase in population of northern Indiana there has come a corresponding increase in dairying, poultry raising, and the growing of fruit, vegetables, and other special or cash crops. This expansion has resulted in some decline in the raising of beef cattle, sheep, and hogs. Dairying and livestock raising are best suited to the rolling morainic districts, in which soils of the Nappanee, Galena, and Hillsdale series are dominant. On these soils a mixed grain and livestock system of farming is followed. These soils are used mainly for the production of corn, wheat, and meadow. Kentucky bluegrass is also adapted and supplies quantities of pasture and roughage for livestock. A grain system of farming is most widely followed in the Kankakee Basin, although dairying is gradually gaining a foothold on the Door, Lydick, and Tracy soils. These soils are devoted largely to wheat. The broad areas of Maumee soils throughout the Kankakee marsh are well suited and extensively used for the production of corn, which is also the principal crop on the organic soils developed in the marshlands of the Kankakee and Lake Michigan Basins. General farming is practiced on soils of the Plainfield and Berrien series and on the sandy members of the Tracy series. Corn is the principal crop on these soils.

Fruit growing is developed largely on the sandy Coloma soils and Hillsdale fine sandy loam. Grapes are the most important crop, although blackberries, raspberries, and tree fruits are also grown, particularly in the vicinity of Lake Michigan.

Truck farming is followed largely near the larger cities, especially on the sandy soils, such as those of the Granby, Maumee, and Berrien

series, throughout the Lake Michigan Basin. The organic soils, represented principally by Houghton and Carlisle mucks, are used extensively for cash crops, such as potatoes, mint, and onions, and they produce high yields when fertilized with high-potash fertilizers. These soils are also well suited to permanent bluegrass pasture.

The mineral soil materials of the county are entirely of glacial origin. Soils of 14.5 percent of the area are developed over glacial till that was deposited directly by the ice; and those of 76.3 percent of the area are developed over glacial materials that have been reworked and redeposited by water and wind. Organic soils and a few areas of miscellaneous materials occupy the remainder of the county.

The soils are variable in character and composition. In many places they vary widely or are intricately mixed within short distances. The texture ranges from plastic clay to loose fine sands, some of which have too inadequate moisture-holding capacities to be highly productive. Probably 85 percent contain sufficient sand so that a good physical condition is easily maintained.

Originally nearly 80 percent of the county was covered with forest, although nearly a third of this was marshland having different proportions of trees and grass. The forest consisted largely of mixed hardwoods, predominantly beech and maple. This type of cover prevailed principally on the upland soils. On the sandy light-colored soils black oaks and white oaks were the most important varieties of trees. All the forest has been cut-over, and probably less than 10 percent of the county is now covered by second-growth trees, which have little commercial value. The well-drained soils developed under a forest cover are comparatively low in organic matter and only moderately productive. About 20 percent of the county was originally a tall-grass prairie, and it is characterized by dark-colored soils comparatively high in organic matter and, therefore, productivity.

On the basis of natural drainage and color the soils and land types are grouped as follows: (1) Light-colored well-drained soils; (2) light-colored imperfectly drained soils; (3) dark-colored well-drained soils; (4) dark-colored poorly drained soils; (5) dark-colored very poorly drained soils; and (6) miscellaneous land types.

The first group includes members of the Galena, Hillsdale, Tracy, Coloma, Plainfield, Lucas, and Bridgman series. The Galena and Hillsdale soils, developed from glacial till, have light-brown surface soils and yellowish-brown or brown subsoils. They are comparatively low in organic matter, moderately acid, and moderately productive. The Tracy soils are similar in color to the Galena and Hillsdale soils but are developed from gravelly and sandy outwash material rather than from till. The heavier textured members of the Tracy series are somewhat like the Galena soils, except that subsoil drainage through the gravelly strata is more rapid. The lighter textured members are somewhat droughty. The Coloma soils, developed from loose sandy till, are best suited to fruit growing, although with good management they can be used for general farm crops. The Plainfield soils are much like the Coloma, but they are developed from wind-blown and water-laid sands that are more highly leached and somewhat more droughty than the parent materials of the Coloma. Lucas fine sandy loam, formed from stratified lacustrine sands, silts, and clays, is a good soil for general farm crops. Most of the Bridgman fine sand is rough and dunelike in

character and not very well suited to agriculture. Much of it remains in forest, and some of it is used for building sites along Lake Michigan.

The light-colored imperfectly drained soils include members of the Berrien, Hanna, Alida, Vaughnsville, Nappanee, Allendale, Otis, Fulton, and Willvale series. Berrien loamy fine sand is associated with the Plainfield soils and is likely to be dry during late summer of each year. This limits its productivity. The Hanna, Alida, and Vaughnsville soils are fairly well suited to general farm crops. The Nappanee, Allendale, Otis, Fulton, and Willvale soils are more slowly drained than the members of the first four series of this group. The Nappanee soils are developed from excessively heavy glacial till and are devoted chiefly to pasture. The Allendale, Otis, Fulton, and Willvale soils are not so heavy textured as the Nappanee soils and are more easily managed. They are fairly well suited to small grains.

The dark-colored well-drained soils have developed on the outwash plains where materials are about the same as those from which the Tracy soils developed. The original vegetation was grass. The Door soils are dark-colored, high in organic matter, and very well suited to grain farming. The Lydick soils are not so dark-colored as the Door soils because of the effects of the comparatively recent encroachment of an oak forest on the prairie. This encroachment took place before the land was settled, but the trees had not been in place long enough to cause the soils to become as light colored as the Tracy soils. Because of its light texture, Byron loamy fine sand does not have so wide a use range as the Door and Lydick soils.

The dark-colored poorly drained and dark-colored very poorly drained soils are the most productive in the county in places where they have been artificially drained. The Brookston soils are developed from calcareous glacial till and are especially well suited to corn. The Washtenaw, Wallkill, and Pinola soils occupy low areas where the original dark-colored surface soil has been covered by wash from higher lying land. They are very productive where they can be drained, but many areas lie in situations where drainage is not feasible. The Wauseon soils are dark-colored soils comprising a thin veneer of sand over clays, and they are well suited to corn and hay crops where drained. Toledo silty clay is developed from lacustrine silt and clay deposits, and it also is very productive where drained. The Granby soils are more sandy than the Toledo soils. They are well suited to corn and alfalfa where drainage is provided. Because they lie in areas subject to flood, the Griffin soils are best suited to pasture but will produce good corn crops if they are artificially drained and if floods do not interfere. The Newton soils are strongly acid in reaction, and they usually are very unproductive until they have been heavily limed and fertilized. The Saugatuck soils also are strongly acid in reaction and need to be limed and fertilized before they will reach their maximum stage of productivity. The Saugatuck soils are not so poorly drained as the rest of the dark-colored poorly drained soils. It should be noted that all the dark-colored poorly drained soils, except those of the Newton and Saugatuck series, are either neutral in reaction or only slightly acid.

All the dark-colored very poorly drained mineral soils belong in the Maumee series, and the greater parts of the soils are medium

acid in reaction. In this respect they differ from typical Maumee soils, which generally are only slightly acid or neutral in reaction. They are well suited to the production of corn where drained, but they all, except in the few areas where the reaction is neutral, need to be limed before alfalfa can be grown and before the best yields of red clover can be obtained.

The dark-colored very poorly drained organic soils include Houghton, Carlisle, Edwards, and Kerston mucks and undifferentiated peat. Most of these soils can be made very productive by good management, including the use of high-potash fertilizers. They are especially well suited to corn, special crops, and pasture but must be artificially drained before they can be used to good advantage.

Miscellaneous land types include marl beds, coastal beach, and pits and dumps. The marl beds are associated with muck, especially Edwards muck, and the marl is used for liming acid soils. Coastal beach borders the shore of Lake Michigan. Pits and dumps represent areas that have been excavated or filled. Most of them are near the larger cities. Pits occur both in sandy and gravelly deposits, and the materials taken from them are used for construction work. Dumps consist largely of city waste of various sorts.

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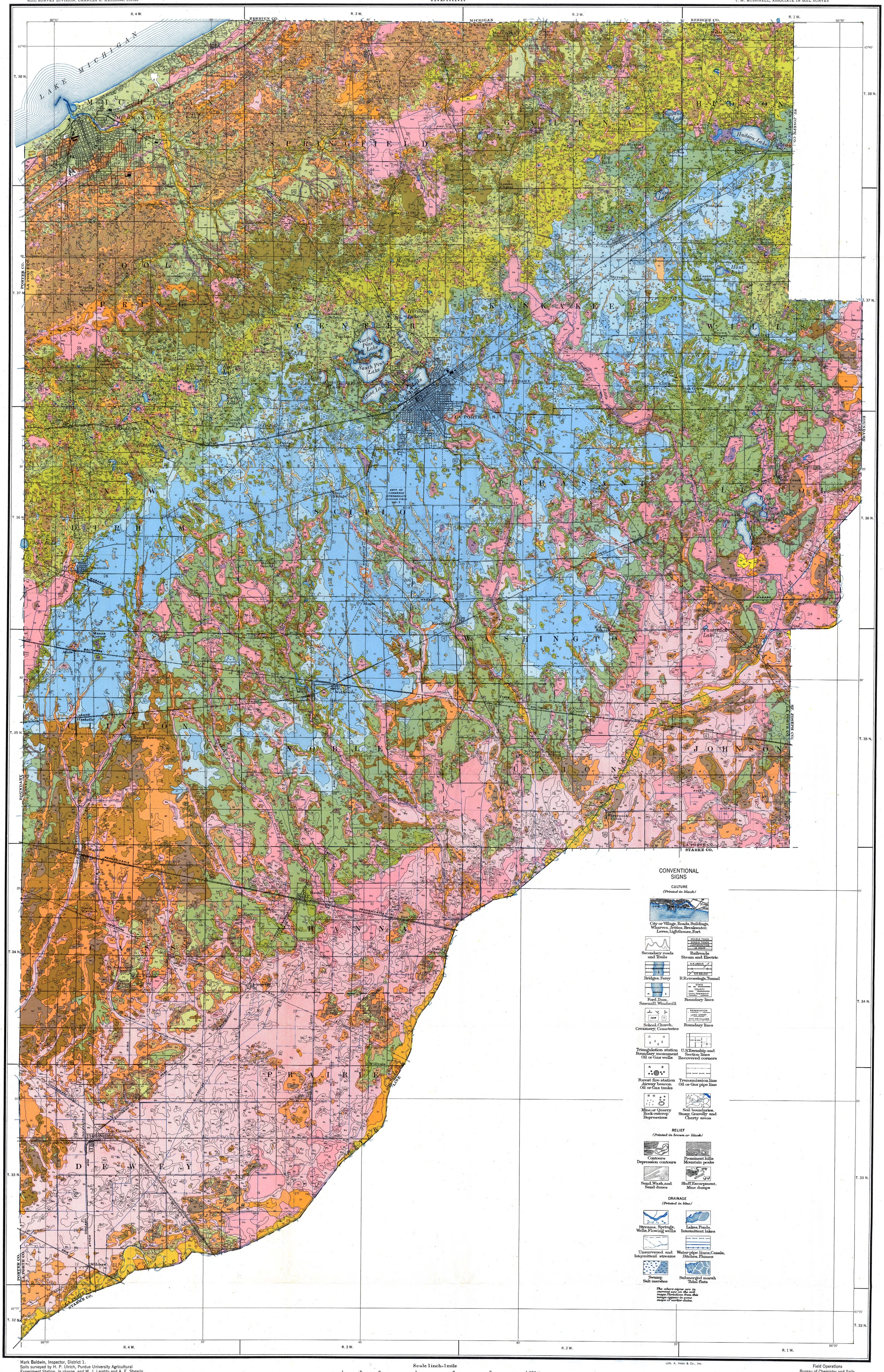
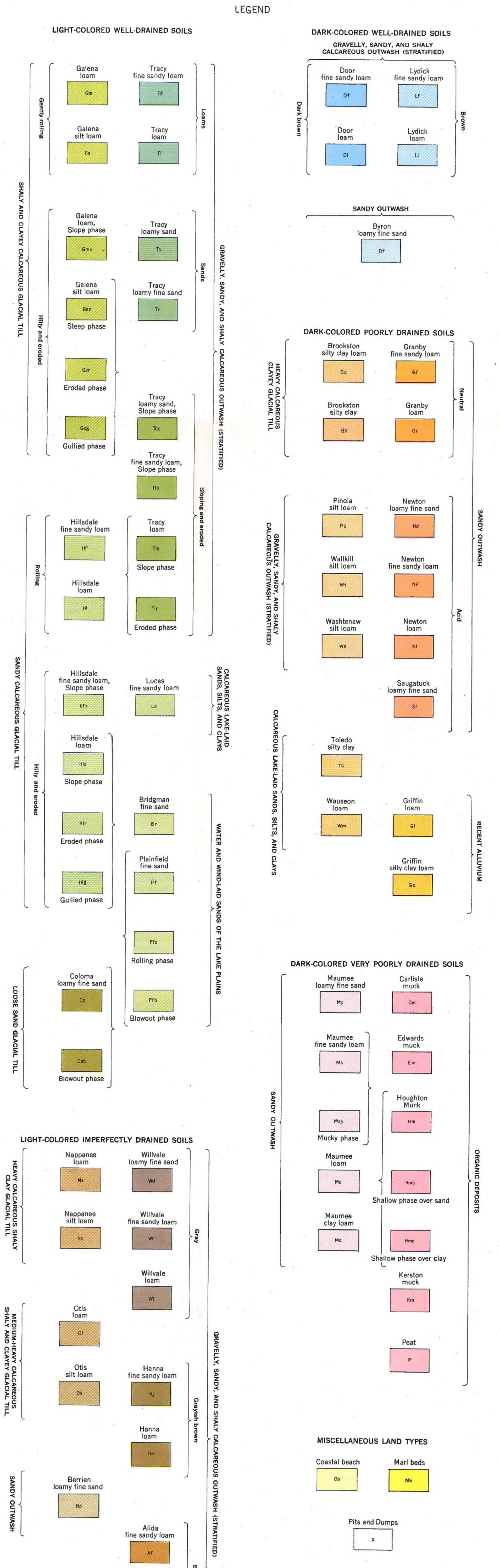
SOIL MAP

LA PORTE COUNTY
INDIANA

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
J. H. SKINNER, DIRECTOR
A. T. WIANCKO, CHIEF, DEPARTMENT OF AGRONOMY
T. M. BUSHNELL, ASSOCIATE IN SOIL SURVEY





Mark Baldwin, Inspector, District 1.
Soils surveyed by H. P. Ulrich, Purdue University Agricultural Experiment Station, in charge, and W. J. Leighty and A. E. Shearin, U. S. Department of Agriculture.

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

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